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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

FEBRUARY 13.

Middlesbrough Branch:—Ordinary meeting.

FEBRUARY 14.

Newcastle-upon-Tyne and District Branch:—Annual dinner.

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. Lecture by R. MacNab.

Lancashire Branch:—Ordinary meeting at Manchester. "Weldings as a New Foundry Application," Paper by P. L. Roberts.

FEBRUARY 16.

Sheffield and District Branch:—General discussion on "Refractories," opened by four short Papers.

FEBRUARY 19.

London Branch:—Ordinary meeting in London. "Moulding a Machine Base," Paper by J. Bennett.

The British Industries Fair.

The heavy branch of the Industries Fair at Birmingham has always been well supported by founders, and the general demand for space for next week's show has been a record. There is no doubt that, in spite of individual dissatisfaction with results here and there, the Fair is growing and is becoming a representative exhibition of British workmanship. We think that many exhibitors and would-be exhibitors in the industry will be interested in the conclusions arrived at by a Government Committee appointed to consider the whole question of the terms on which the Government supports the Fair. They have only recently been published. The Fair in the past has had official support and a grant of £25,000 for advertising abroad.

The recommendations, which speak for themselves and do not call for comment, are as follow:—Space charges should not be increased to meet advertising expenses. The Government grant should be increased to, and maintained at, £100,000 per annum, administered by the Department of Overseas Trade.

On the important question of the date of the Fair, it is recommended that the date be not altered, and also that a second Fair should not be held in the autumn.

For the London section, a central site capable of extension as required is recommended, and the allocation of business between the London and Birmingham sections is to stand as at present.

It is recommended that trade buyers should have exclusive access to the Fair during the hours reserved for them, and that kiosks should be opened to put the public into touch with retail buyers.

The Fair is to continue to be confined to British goods, and the existing regulation regarding the eligibility of exhibitors is to stand. There are other recommendations designed to make it easier for foreign buyers to come and to be entertained and interested while they are here.

Anyone who knows the great foreign fairs, such as Leipzig, would say that our fairs lack dignity and artistic treatment, and now they are well established, the co-operation of architects and artists might well be sought in making the exhibition not merely a great trade show, but such a display of taste and dignified presentation as will make a permanent impression on the minds of buyers. Everybody capable of making suggestions, from landscape gardeners to film producers, skilled in producing visual effects simply and cheaply, should be pressed into this service.

From Small Beginnings.

Some little time ago we were asked by the owner of a small yet prosperous jobbing foundry to solve the following problem:—"I have placed during recent years £2,000 to reserve, and I desire to expend this on new plant which will bring me in a profit. Beyond a simple sand-preparing plant and an electric hoist for the cupola, I possess no machinery." As his costs were particularly low, we hesitated, and confess that even now, after much thought, we still are not sure that our advice is the best in his particular case, but the following is enunciated as a working fundamental principle underlying the mechanisation of iron foundries. The first step is the creation of a moulding unit, consisting of moulding machine and a sand machine capable of filling an overhead hopper. The second step is the installation of a conveyor or other means of getting the moulds away from the machine. Next, one would arrange for the return of the boxes or snaps or slips—a turntable slung on ball bearings, of course, replaces two conveyors. Presuming that so far this small piece of mechanisation has been successful, the management will now find itself at the cross-roads. It can multiply the units or install a central sand-preparing and distributing plant. In either case the question of backing sand will by then be settled, and the movement of the facing sand would be left till a later stage or perhaps eliminated altogether. About this time an analytical service would be arranged for.

Attention would then be given to the transport of the raw materials—coke and pig-iron from the truck to cupola and the liquid metal to the moulds—by eliminating as many handlings as possible. The final phases in mechanisation would be carried out in the following order, assuming, naturally, that the foundry has now grown to considerable dimensions. The castings would be mechanically removed from the foundry, the cores would be dried in a continuous furnace and conveyed to the machines, and the facing sand—if this be an essential—also would be automatically available above each machine.

Here, then, are the steps we advocate for the gradual conversion of a country jobbing foundry into a mass-production establishment. No great cost is involved until the point is reached which we alluded to as the "cross-roads," when, in order to avoid future difficulties, the complete development should be envisaged before installing a single unit.

XUM

London Foundrymen to Visit Cork.

Mr. J. W. Gardom, a Past-President of the London Section of the Institute of British Foundrymen, has kindly consented to organise a visit to Cork in response to an invitation extended to the Branch by Messrs. Henry Ford & Son, Limited, manufacturers of the well-known Ford Tractors. Below we outline the proposed programme. The party will leave Paddington on Saturday, March 14, at 5.50 p.m., travelling 3rd class to Fishguard. Leaving Fishguard by M.V. "Innisfallen," the party will arrive in Cork at 9.30 a.m , travelling saloon, double-berth cabins, and taking breakfast on board.

Sunday will be taken up with a motor-coach excursion to Killarney via Glengarrick, where luncheon will be taken, with tea at Killarney. Hotel accommodation will be reserved in Cork for the Sunday night. On Monday the works of Messrs. Henry Ford & Son will be visited. The party will leave Cork on Monday evening at 6, taking dinner on board ship, and arrive at Paddington at 9.30 a.m. on Tuesday. The inclusive cost, if the party numbers 20, will be exactly £6 10s. per head. This figure will include all meals, rail and steamship tickets and hotel accommodation.

Though this is being organised primarily for the benefit of the London Section, members of the Institute will be welcomed. Further information can be obtained on application to Mr. Gardom, 39, St. Peter's Road, Dunstable, Beds.

History of Technology Congress.

The Second International Congress of the History of Science and Technology will take place in London from Monday, June 29, to Friday, July 3, 1931. The headquarters will be the Science Museum, South Kensington. The Congress originated with the *Comité International d'Histoire des Sciences*, which was founded at Oslo on August 17, 1928. This body meets annually in Paris and organises every three years a congress, in which persons interested in the history of science and technology are invited to take part. For the coming Congress the *Comité* has been fortunate in enlisting the co-operation of its parent body the *Comité International des Sciences Historiques*, together with that of two other international Societies; the *History of Science Society*, Washington, D.C., and the *Newcomen Society for the Study of the History of Engineering and Technology*, London. The aim of the Congress is to provide opportunity for intercourse and exchange of thought between all those who are interested in the various departments of the History of Science and Technology.

Notes from I.B.F. Branches.

Sheffield Branch.—In an endeavour to bring its members closer together and to stimulate their interest in the Branch, the Sheffield Branch has decided to form a debating society, of which each member of the Branch will automatically become a member. The subjects debated will not be exclusively confined to purely foundry matters. The first meeting, to which members and interested friends are invited, will be held on Friday, March 6, in the Albany Hotel, Sheffield, commencing at 7.30 p.m. The subject is "That the present-day standard of craftsmanship is lower than it used to be." This will be proposed by Mr. J. T. Goodwin, whilst the opposition will be led by Mr. W. T. Kitching. Further information may be obtained from Mr. T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.

A New Furnace Company.

Messrs. Gibbons Brothers, Limited, Dibdale Works, Dudley, in conjunction with Messrs. Wild-Barfield Electric Furnaces, Limited, Elecfurn Works, North Road, Holloway, London, N.7, have acquired from Messrs. Rudge-Whitworth, Limited, Birmingham, as from February 1, the sole manufacturing and selling rights of the well-known carburising compound "Eternite."

The same staff for manufacturing has been retained, and every effort will be made to maintain the highest quality of this well-known compound.

In connection with the above, and also the acquisition for the manufacture and sale of mechanically-operated furnaces, Hevi-Duty Electric type (under agreement with the Hevi-Duty Electric Company, Milwaukee, U.S.A.), we understand that Messrs. Gibbons Brothers, Limited, and Messrs. Wild-Barfield Electric Furnaces, Limited, are forming a new company under the title of "G.W.B. Electric Furnaces, Limited." The whole of the share capital of which will be held by the firms named.

London Iron and Steel Exchange.

Proposal to Form Sectional Trade Committees.

The annual meeting of the London Iron and Steel Exchange was held at the Cannon Street Hotel, London, on January 27. Mr. Cyril Watts (South Wales Tinplate Corporation, Limited), Chairman of the Committee, presided. In a brief review of the working of the Exchange during the past year, Mr. Watts referred to the monthly luncheons which had been held and at which a number of interesting addresses had been given by prominent men. It had been decided, however, that in future there should be no fixed period for these luncheons, but that they should be held when it was considered advisable. Due notice of the functions would be given to the members. In accordance with the expressed desire of many of the members the Committee had decided to continue to hold weekly meetings at the Cannon Street Hotel on Tuesdays.

Turning to the future of the Exchange, Mr. Watts said that the Committee had considered the possibility of bringing various sections of the trade represented on the Exchange more closely into touch with each other. The Committee wished that meeting to consider a proposal which had been made that Committees should be formed representing the various interests, such as stockholders, importers, etc. It was particularly desirable that the Exchange should work as far as possible in co-operation with the British steel manufacturers. Some of the manufacturers had been approached, and he (Mr. Watts) thought that if strong Committees were formed, when any question affecting the section of the trade thus represented came up, the manufacturers would be prepared to hear what they had to say. He thought that by this means they could bring about a great deal of useful co-operation in the iron and steel trades.

Mr. Baxter strongly supported the idea of negotiating Committees. There was no other organisation similar to the Iron and Steel Exchange, which represented practically all sections of the iron and steel trades. There were many questions which these Committees could take up. For instance, if there were a Merchants' Committee, it could put forward its views upon some of the questions which were outstanding between that class of trader and the manufacturers, and benefit to both sections might result.

Mr. James Whitby also supported the proposal to form Committees. He thought that if a strong Committee, which settled beforehand upon what it wanted, approached the manufacturers, they would be prepared to listen to it and meet it if possible.

Mr. Lockwood, of Messrs. Stewarts & Lloyds, Limited, suggested that it would be a very good thing to form a Pig-iron Committee, which might also bring into the Exchange a certain number of coal and coke firms and founders in London and the South. So far as he knew, there was no place in which these sections of the trade could meet and discuss their business.

After some further discussion it was decided unanimously that the General Committee be asked to proceed with the formation of Committees representing the stockholding and the pig-iron trades.

Random Shots.

There appears to be an epidemic of influenza at the moment. Two months ago doctors and nurses were complaining, like the rest of us, that trade was bad. Now they are overworked. This reminds me of a meeting I had some time ago with a man—a successful business man—who, while not far off the Psalmist's three score and ten, has the carriage and complexion of a man of forty. Naturally his friends asked, as I asked, how it was done. For reply he lent me a small manuscript explaining how, although up to forty very subject to colds and influenza, he had succeeded in remaining entirely free from them for nine years.

* * *

Having succeeded myself in a measure in diminishing a similar tendency, I was naturally interested, and I pass the information on, because the ravages of these tiresome complaints concern most of us. I may say that I never met a man less like the ordinary health crank. He didn't run to long hair and queer views on life. He was what most of us would describe as a sport. He didn't drink alcohol, but he was game to stay up till the small hours drinking a "Polly" or something equally harmless, and his cigarettes had certainly been de-nicotinised.

* * *

He explained that his system involves self-denial and self-sacrifice, but, as he put it in his manuscript (which has since been published at a shilling), "the sleep of a child, the digestion of a ploughman, and the outlook and enthusiasm of youth, in the sixties, are possessions which too often millionaires cannot buy." The principle is to build up bodily resistance by fresh air, sunshine, correct clothing, proper food and drink, exercise, rest, the right mental attitude, and finally, proper elimination of bodily wastes. Most of these do not need elaboration, but on the question of mental attitude, he is neither a Christian Scientist nor a disciple of Coué. He is optimistic, good-tempered, tolerant, and does not permit fear, greed, envy or hatred to depress his bodily resistance.

* * *

I hope this doesn't sound too much like a sermon. Perhaps his most striking advice is in regard to food. For breakfast he recommends half a pound to a pound of sound, ripe fruit and a glass of fresh milk, cold in warm weather and warm in winter. For lunch he has an ounce to two ounces of cheese (plain or cooked with vegetables or macaroni) or an egg dish with a salad, followed by a sweet and coffee. For the main evening meal he recommends a vegetable soup followed by fish, flesh or fowl (preferably fish) cooked with two vegetables, followed again by ripe fruit and nuts. No drinking at meals, but plenty of water in between is advocated.

* * *

Perhaps this may sound a counsel of perfection, but I think many of us could arrange to follow such a scheme with less trouble than we take over matters of less ultimate importance to ourselves, our families, and to the community at large. And I repeat that I never met a man with more obvious good spirits and enjoyment of life, or who was more appreciated by young and old alike. At any rate, I confess that he convinced me that this familiar advice can be followed without becoming inhuman. If you doubt what I say, try it! But take the advice he gives as I took it. Go gently. Don't overdo the zeal for reform, because then you make life so unbearable to one's self and everybody else, and a return to older ways is inevitable.

Marksman.

Steel Foundry Welding.*

By V. Gordon Pearson.

In presenting a Paper on this subject it is thought necessary not only to deal with the practical details of welding, but to discuss the principle of welding steel castings, the attitude of inspection towards welding, and typical casting defects. It is common ground that to repair a casting by welding adds to its cost of production and should be excluded if at all possible. It is therefore the aim of all engaged in foundry work to produce perfect castings.

In a well-organised foundry there is an inspection staff whose first duty is to examine the castings as soon as possible after removal from the mould, to see if there are any defects. The foundry manager will be at once acquainted if there are defects, and he will hold a "post mortem" in order that a repetition of similar trouble may be prevented. Unfortunately, there are many agencies, apart from raw materials, which may bring about defects, *e.g.*, steelmaker, moulder, coremaker, closer, or a designer without foundry knowledge, may be at fault, and though a foundry manager may do all he can, a defect checked in one direction may arise in another.

It is no exaggeration to say that every steel foundry throughout the world has its share of defective castings. After personal visits to foundries in this country, America and France, the author has yet to see one that can dispense with its welding outfit. He is quite convinced that the entire elimination of casting defects is not yet within our grasp.

There are people in the foundry industry who do not like to admit that they weld, and it is common practice, it is thought, to install the welding outfit as far from the eye of the inspector as possible. This is quite wrong, and so long as welding is put in the background and looked upon with suspicion, no good will come from it.

Since welding is an essential, it should be brought into the limelight, and every possible opportunity for discussion, research and improvement of it should be given. The welding plant is a distinct asset to a foundry, quite apart from repair work, as it makes possible the welding on to a casting of brackets and bosses which, if cast as an integral part, would be a source of danger.

Attitude of Inspection.

In dealing with the attitude of inspection it is realised that delicate ground is being traversed, because welding is not a permissible foundry practice in every quarter. Having been in close contact with inspectors for twenty years, the author is aware that their attitude in general is hostile to welding. Fifteen years ago he would have been inclined to agree that there was every reason for hostility, because of the very bad results obtained through the medium of the carbon arc. To-day, however, the case is entirely different, and although welding practice has not advanced so far as in foreign countries, very great strides indeed have been made, and if inspectors were to look into welding possibilities with unbiased minds they would be amazed.

Technicians have as yet only touched the fringe of welding. The lead given overseas in the extension of its utility will undoubtedly be followed. However, a more tolerant attitude should be accorded to the welding end of the foundry industry, and it is difficult to understand why fabrication should be so readily accepted when trivial repairs to steel castings are rejected.

Undoubtedly most inspectors would prefer to undertake the inspection of a fabricated article rather than come into a steel foundry and consider the repair of a casting, but when the two cases are considered, the foundry repair is, obviously, much the safer proposition. Where the work is fabricated, a price has been given for doing the job, and it is to the firm's interest to do the work as cheaply as possible, which means there is a danger of unsuitable electrodes being used and the welding being carried out at too high an amperage. On the other hand, steel founders are not commercial welders and only have quality to consider.

The most important matter, however, is that every casting which is welded should be annealed, normalised or tempered after welding, but this is not done in the case of fabricated work, which goes into position with definite strains in it.

A general complaint by inspectors is that one cannot see below the surface of a weld. This is certainly true, but the surface in itself indicates to the experienced eye what lies below, and constitutes a very clear indication, indeed, whether too much or too little current has been used and whether slag pockets are likely to be found. It is not desired to be hypercritical of inspectors, as it is realised that they have a multitude of materials to deal with and cannot be expert in all branches of their business. It is felt, however, that they might take the man in charge more into their confidence, with the result that every facility would be given them to get a more thorough insight into the question.

No firm would ask permission to weld a casting if they doubted their ability to give satisfaction. It must be conceded that a firm is in business to make money, and cannot thrive on bad workmanship. Take the author's own case, for example. He is entirely responsible for steel castings going away in the best possible condition, and as a result of fourteen years of close connection with welding, he has gained certain experience. If a weld proved a failure, he would immediately lose prestige and risk losing his position. Obviously, therefore, he would put no defect forward for repair unless he was sure of his ground.

Personal opinion is that the matter can be based on a sounder footing, which would help inspection and benefit welding. National bodies, such as the Board of Trade, the Home Office, or the British Engineering Standards Committee, should enter the field and set up a definite standard of plant, materials and workmanship. For years there have been factory inspectors visiting works to ensure the safety of workpeople, yet any Tom, Dick or Harry can weld an article, and the result of this welding may, at a later stage, imperil life.

There are welding machines totally unsuitable for the control of electrodes, and electrodes quite unfit for the job, and, in consequence, the whole welding world has to suffer. If steps were taken to certify a company's fitness to weld, it would be a great boon to inspection and welding and such measures should be adopted.

If the author were an inspector and had to consider a repair, he would first of all want to know the history of the case. If an article had broken through natural causes, he would refuse permission to weld, because it would break again unless considerable reinforcement could be made. He would also demand to see the plant, the operators working, and to have made whatever tests thought necessary to give an impression of the firm's ability to produce strong welds, free from porosity and slag inclusions.

Delay and needless expenditure are caused through lack of appreciation of welding possibilities by inspectors; the most conservative of which are Government departments, which are very much behind the times. For example, they appoint competent engineers as district overseers. It is incredible, but true, that these gentlemen are not allowed one iota of discretion in regard to the repair of steel castings, no matter how trivial the defect. Such a decision is an insult to an overseer's intelligence. In consequence, considerable formalities have to be observed, causing delay.

No welding is allowed to a pressure casting where strength is involved, but sometimes a screwed plug may be inserted, which means that good material has been needlessly removed from a casting. How the authorities' particular fear of welding has arisen it is difficult to say. It may have arisen from their own works, but from whatever source the fear emanates, a process of elimination should take place to bring the art of welding at least up to the German standard.

If Germany can build a battleship by welding, some of our own rejections look rather absurd. From what one has heard of German welding methods, it is not presumption to say that the British can put forward a higher standard of efficiency.

Welding of Steel Castings.

In considering the welding of steel castings, the first thing to know is the character of the defects. There are several possible types of defects, the principal ones being: Porosity, dirt inclusions, cores out of position, clinks and pulls. One of the most difficult jobs to repair is the porous casting, and the casting should certainly be rejected if porosity is likely to impair its strength. However, the porosity may be localised and capable of being chipped out, or it may be general, but only a perfect surface is required. In this case, where strength is not of vital importance, the chipping out of the surface to, say, $\frac{1}{2}$ in. deep, hammering out all the defects, and reinforcing with a good weld metal is suggested.

The dirt inclusion is a defect of very little consequence, and is caused by dirt in the mould rising with the steel and sticking against the side of the mould, or perhaps by a crush. It is rarely of any great depth, and by chipping all clear a satisfactory weld can be made; in the case of cores being out of position, this is merely a case of reinforcement on one side of the hole.

The last two defects—clinks and pulls—often give rise to confusion. Generally speaking they were incorrectly classed under the one heading, *i.e.*, cracks. A crack is not a pull. It is what the foundry world call a "clink," and can be easily detected by the sharply-defined line produced in the casting. The pull is better described as a "tear," and has the appearance of an irregular jagged edge. Both these defects spring from the same source, but they occur when the steel is in a different condition. It will often be found that where a casting of any appreciable length is intersected with bosses, cores and brackets, a tear has taken place. If one imagines a long casting contracting in the mould, one will realise that in order that regular contraction may take place, there must be no obstruction. If there is an obstruction which will not collapse, something is bound to happen to the casting; while the contraction is going on, the metal may tear whilst plastic and so release the strain.

On the other hand, if the obstruction does not give way, and the casting does not tear, a strain will be left in the casting which may, or may not, be removed by annealing. If the strain is not removed, it is possible that the casting will "clink," *i.e.*, crack. This is the most dangerous of all defects. There is not the slightest fear of a "tear," but a "clink" may extend at any time.

If a repair has to be carried out to a "clinked" casting, it can sometimes be successfully done, but the author would certainly never attempt one unless each end of the crack was drilled to a total depth of the crack to prevent spreading, and even then the casting would have

* A Paper read before the Institution of Engineering Inspection yesterday. The author is on the staff of Messrs. Edgar Allen & Company, Limited

to be preheated and welded while warm and put back into the annealing furnace before it was cold.

Training an Operator.

Dealing with the practical side of welding, the first and most important matter is the training of operators. It is claimed by welding companies that operators can be trained in a fortnight. The welding companies are, of course, out to sell their product and make it look as appetising as possible, but the author would certainly not like to engage an operator on work of any description unless he had him under strict supervision for a month, and even then he would only do the less important work for months. The cost of putting men through an intensive training is considerable, but a firm is amply rewarded by doing so. The A.B.C. of the business is slag control, and the necessity for perfection cannot be overstated.

The beginner will first of all spend a day or so with a skilful operator, who will instruct him in length of arc, width of deposit, and the correct amperage for each gauge electrode. He will then learn to strike the arc and to maintain it, which will be made easier by using a higher amperage than is required in regular routine. Hand control is such an important matter that the pupil should practise at home with paper, pencil and pliers. Lines would be drawn on the paper representing the width of the deposit. The sweep of the arc can then be marked on the paper, the pencil, of course, representing the electrode. The first week will be spent in depositing metal in straight lines on to a plate, and until perfection can be attained, he must not tackle the next exercise of joining one line to another. Slag pockets and their cause should be pointed out to the learner; they are due to incorrect lateral movement and lack of feed. Every beginner attempts to use an electrode as he would a paint brush, forgetting that it is melting away and requires feeding down in a regular manner.

The utmost patience must be given when teaching, emphasising that only quality really matters. At least 2,000 ft. of electrodes and a great deal of scrap plate will be swallowed up in conquering the first principles of welding. The third exercise should be the most important to the operator and instructor—the building up of a "V" approximately 4 in. by 8 in. by 2 in. deep. This specimen, when finished, will be sawn into sections and examined for penetration, slag inclusions and porosity. Similar "V's" must be filled until perfection is attained, after which the learner will begin welding test specimens, when his greatest interest will be aroused, and his desire to attain high-grade results increased.

By the time one is through with these tests, judgment can be given definitely whether or not the operator is likely to be successful. If it is decided that the man should continue, he will be clearly told that advancement to the top scale is by ability alone. Periodical testing, not only of beginners, but of all operators, must be carried out to ensure that standard workmanship is being maintained, and also that the electrodes are beyond suspicion.

Preparation of the Work.

This will not concern the men, as the work is prepared for them. They know, however, how the work should be prepared, and should have strict instructions not to commence operations unless it is prepared in the best possible manner. It is essential that the defect in a casting should be cut out right to the bottom, and that in forming the "V" the walls must not be steep, always keeping in mind the necessity of making the conditions of welding as easy as possible for the operator.

As a general guide, the width across the top of the "V" should be 1½ times the depth. This, however, is not a hard-and-fast rule, as in greater thicknesses it is necessary to increase the width. If good results are to be obtained, one must not be afraid of cutting away plenty of parent metal.

The choice of electrodes is a matter for the manager, who will select them after the most exhaustive tests have been made. Unfortunately, people often get away with poor electrodes through lack of knowledge on the part of their customers. A traveller merely says that he has some electrodes for sale cheaper than those which are being used. He probably leaves a sample, which is given to the welder for trial. The welder's word is the only consideration given; price is the last matter to be considered. Having tried very many makes of electrodes, for steel foundry work the author is convinced that the best type is the heavy-coated one. There certainly are fields for bare wire and the dipped electrode, but it is necessary, in the foundry trade, to repair with materials as near as possible in analysis to the casting itself, and if this analysis is given to the electrode maker, he will produce an electrode which is extraordinarily near to the correct composition.

In testing operators' work, a test is never made on ⅜-in. plate, because this means that only two or three deposits have been made, and it is possible that an operator might put down two runs in a perfect manner and not get perfect results from 10 layers. The minimum thickness of the test-piece is 1¼ in., and it is 3 in. wide at the top of the "V." Also, it is important that the material to be welded for the test-piece should be of a higher tensile steel than the weld itself. It may be impressive to weld pieces of low tensile steel together, and so make the fracture outside the weld, but it is useless if one desires to examine the interior of the weld. The results obtained from these tests give a tensile strength of 28 to 30 tons per sq. in., 10 to 15 per cent. elongation and 20 to 22 tons yield, free from porosity and a bend of 90 deg. These tests can be repeated again and again by every one of the author's operators, and, if inspecting any work, he would want to see the same result produced.

It is frankly admitted that some very bad work is done throughout the country. One of the worst cases encountered was the repair of a casting which had practically broken its back. It was a casting of a box section which had "clinked" across the back, and the clink extended down the side. The trouble did not originate in the foundry, but was the fault of negligent treatment on the part of another firm. The author was called in to see this case, which was a desperately rushed job. The result was that, when he went on the Monday morning, this particular firm had been working on it all the week-end, milling out a little channel 1 in. deep by 1 in. wide along the defect, thinking it quite unnecessary to get to the root of the trouble, although the casting was designed for a certain thickness, to meet the demands required of it. They had actually commenced welding it when he arrived. The casting was dead cold, and the welding could not have been carried out in a worse manner. The result was that the author sent for his own man, had a temporary oven built to preheat the casting, and, when finished, put it into this oven for cooling off. A letter was sent to the technical director of this company, pointing out the damage he was doing to the welding cause, by such an appalling exhibition of welding, and suggesting that they should send their operator to London to go through a course of training and learn the A.B.C. of the job. It is very pleasing to record that he fell in with this view.

Another appalling case was the welding of a large cavity in the root of an anchor. The hole was filled with scrap and flushed over by means of the oxy-acetylene flame. Such cases as these will naturally damage welding, but if there was some form of control, as outlined previously, they could not exist.

Does Welding all Depend upon the Operator?

It most emphatically does not. It depends upon the firm who have chosen the operator, trained him, periodically tested his work, chosen electrodes, and prepared work for him. All he has to do is to work as he has been trained, and since his bread and butter depends on his skill, he is not likely to do a bad job of work on purpose. Quite apart from this, pride of craft is very much to the fore in this art, and operators are intensely keen and zealous.

For instance, one case in particular, that of a locomotive smokebox saddle which was welded from end to end and across as well, was subjected to the tup test. The tup weighed 35 cwts. and was allowed to fall on the welded portion from a height of 27 ft. The casting deflected 7 in., and by repeated tests of this nature fracture did occur, but not through the weld nor in close proximity to it.

In conclusion, it seems desirable to lay stress on the fact that excellent results can be achieved under favourable conditions, but it is necessary that compulsory action should be taken to standardise welding conditions, and so prevent failures which must retard the progress of this art.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for December, report that pig-iron production in December again declined and amounted to 349,800 tons, compared with 384,100 in November and 643,000 tons in December, 1929. With the exception of September there has thus been a continuous decline in output since March last, when production amounted to 665,800 tons. The number of furnaces in operation declined by 16 to 76 during the month, 11 having been "damped down" and five blown out. The production of pig-iron for the year has amounted to 6,196,800 tons, a figure lower than in any post-war year except 1921, 1922 and 1926, which were affected by stoppages in other industries. Table I compares the production of pig-iron in the various districts in 1913, 1929 and 1930:—

Steel production in December showed a decline of nearly 100,000 tons compared with November and amounted to 337,200 tons, many works closing down for the Christmas holidays for a longer period than usual owing to the general slackness of demand. The December production brings the total for the year to 7,298,500 tons, or 2,337,700 tons less than in 1929.

Table I.—*British Production of Pig-Iron, by Districts, in* 1913, 1929 *and* 1930. (1 = 1,000 *tons.*)

District.	1913.	1929.	1930.
Derby, Leicester, Notts and Northants ..	1,166.1	1,174.2	1,120.4
Lancs and Yorks ..	503.5	472.4	387.5
Lincolnshire	450.0	864.7	751.7
North-East Coast ..	3,869.0	2,349.1	1,864.9
Scotland	1,369.2	607.1	467.9
Staffs, Shrops, Worcs and Warwick ..	850.7	439.9	377.9
S. Wales and Monmouth	889.2	926.5	539.8
West Coast	1,162.6	755.4	686.7
Total	10,260.3	7,589.3	6,196.8

Representatives of 42 unions in the engineering trade attended a conference in London last month with representatives of the Engineering and Allied Employers' National Federation to discuss the question of wages and working conditions. Sir Allan Smith put the employers' case fully to the men's representatives, who decided not to make any reply then, but to hold a conference of their own on February 24 and meet the employers again early in March. The employers proposed the extension of the working week from 47 hours to 48 hours, a reduction of the overtime rate to time and one-ninth instead of time and two-thirds, and a reduction of the night-shift rates. It is understood that the unions' reply will be a counter demand for a wage increase.

The Vitreous Enamelling of Cast Iron.*

By J. H. D. Bradshaw.

Almost everyone is familiar with cast-iron enamelled articles of one kind or another, and as typical examples may be mentioned such commodities as baths, sinks, saucepans, kettles, firegrates, stoves and other castings. By the aid of the enamelling art a rough, crude and unattractive casting may be transformed into an article of beauty, and in this direction one has only to contrast the difference between, say, a bath casting as it leaves the foundry and the beautifully-enamelled article one sees in the showroom of a builders' merchant or perhaps at some exhibition.

An Ancient Art.

The enamelling of cast iron is a modern development of the very old art of enamelling on metals. This art is of such great antiquity as to render it difficult, if not impossible, to trace to its origin. It was undoubtedly practised by the Egyptians, as evidenced by the remains that have been observed on the ornamental envelopes of mummies. From Egypt it passed into Greece and afterwards into Rome and its provinces, whence it was probably introduced into Britain, as various Roman antiquities have been discovered in various parts of the island, particularly in the barrows, in which enamels have formed portions of the ornaments. The gold cup given by King John to the Corporation of Lynn, in Norfolk, proves that the art was known among the Normans, as the sides of the cup are adorned with various figures, whose garments are partly composed of coloured enamels.

The Colouring of Enamels.

Enamels are vitrifiable substances and may be divided into three classes: (1) transparent, (2) semi-transparent, and (3) opaque.

The basis of all enamels is a transparent and easily fusible glass, which may be rendered semi-transparent or opaque, and even coloured by the admixture of metallic oxides. White enamels are produced by the addition of tin oxide together with just a little manganese dioxide, which renders the enamel more brilliant and of a purer colour. Yellow colours are obtained by the addition of lead and antimony oxides, or, better still, by means of silver oxide. The best yellow tints are, however, produced by means of cadmium sulphide. Reds are formed by an intermixture of the oxides of gold and iron, that produced by the former being the most beautiful and permanent. Greens, violets and blues are formed from the oxides of copper, cobalt and iron, and these when intermixed in different proportions afford a great variety of intermediate colours, thereby placing a large and varied palette at the disposal of the enameller. Depending upon the type of enamel required, the colouring oxides may either be added to the frit, *i.e.*, fused in the enamel, or they may be added at the mill. If the former method is used there is a tendency for the oxides to go into solution, thereby giving, or tending to give, a transparent but nevertheless coloured enamel. On the other hand, when the oxides are added at the mill, the tendency is for the colouring particles to remain in suspension, thereby producing, or at least tending to produce, an opaque enamel.

A Secret Art.

The art of enamelling, or, more correctly, the art of mixing or compounding the enamel, was, until recent years, one in which the utmost secrecy was observed. Recipes and formulæ were most jealously guarded, and even to-day instances are known where formulæ are kept in locked books, the latter also being kept under lock and key. With the advent of the scientifically-trained worker into the industry many of the supposed mysteries are being explained, and it is safe to say that a true enamelling expert can, after a little while, reproduce any enamel which formerly was supposed to be the exclusive property of one individual.

Reliable enamelling literature and data are still undoubtedly very scarce, especially in scientific books, such as would make a hitherto purely empirical province accessible to science. So far as metallurgical text-books are concerned, the only reference made to enamels known to the author is in Stoughton's "Metallurgy of Iron and Steel," and even here only one paragraph of eleven lines is devoted to the subject. It is, in fact, this scarcity of literature that is partly responsible for this Paper.

Basic Desiderata.

In connection with the enamelling of metals it may be stated that at the present time sheet iron or steel, cast iron, silver, gold, gilding metal and silveroid are being successfully enamelled. The fusibility of the enamels varies, of course, according to the fusing point of the metal on which they are to be applied, and are so compounded as to adhere firmly to the metal after firing. For sheet or wrought iron and steel, hard leadless enamels are applied which will withstand the wear and tear to which culinary articles and advertising signs are subjected. In the case of cast iron, however, more fusible enamels must be employed, owing to the lower melting point of the metal. Many of these enamels contain lead, although there is a trend in the trade towards the abolition of such enamels, which frequently also contain arsenic in considerable (say, up to 6 per cent.) quantities. Enamels for use on copper, silver, gold, gilding metal and silveroid are intermediate in fusibility between those used for steel and cast iron. The principal quality of good enamel and that which renders it fit for being applied to metals is the ease with which it acquires lustre at a moderate or cherry-red heat, without entering into complete fusion. Another important point is that it must have a similar coefficient of expansion to the metal to be coated, otherwise "crazing" will occur. Should the variation in expansion coefficient be very great, then not only will crazing take place, but the coat of enamel will crack and fly away from the castings.

One may consider the enamelling of cast iron in three stages, composed of: (1) The production and preparation of suitable castings; (2) the preparation of the enamel, and (3) the application of the enamel to the castings.

Production of the Castings.

"Bad castings" is invariably the excuse put forward by the enameller when producing inferior work, and, whilst admitting this is frequently correct, it is not always the case, and great care and experience is necessary in placing responsibility for wasters. Speaking generally, the writer has yet to encounter a class of men who are more willing to pass on responsibility for bad workmanship than the enamellers. When bad work is being produced, it is either a "poor muff," "bad castings," or "rotten enamel" that is the cause, and never the enameller.

Castings for enamelling should have a good, clean surface, free from blow-holes, roughness, scabs or other surface defects, and should be so designed as to be free from sharp angles or corners, as enamel will not adhere to such, but will simply flow away from them, leaving unsightly metallic edges projecting through the enamel, which considerably detract from the appearance of the finished ware. All corners and edges should therefore be given a slight radius. Thickness of section should be kept as uniform as possible, thick heavy bosses adjoining a thin section must be avoided, for they are (owing to the unequal heating and cooling) a considerable source of anxiety to the enameller, and it is very often impossible successfully to enamel such castings.

Composition of Metal.

It is essential that iron intended for the production of castings suitable for enamelling should be of uniform and regular composition. Such castings being usually of the thin-walled type, an iron fairly high in silicon is generally employed, a typical analysis being:—T.C., 3.5; Si, 2.5 to 3.0; Mn, 0.3; S, 0.08; and P, 1.5 per cent.

In Continental and American practice, the phosphorus is usually in the neighbourhood of 0.5 per cent., with a slightly higher manganese content up to 1 per cent. A combined high-phosphorus and high-manganese iron should, however, be avoided by all means, otherwise the combined embrittling effects created by these two elements may prove disastrous during the subsequent heating. This fact needs special emphasis when one remembers that the bulk of iron castings intended for enamelling are of extremely thin section. The castings must be poured hot, and should it not be possible to keep exactly within the above specification, then by all means keep the silicon above 2.5 per cent. Scrap, especially the bought variety, should not be used to any great extent owing to the enormous differences in its composition. In fact, experience has shown that it is far safer to work an all-pig mixture, this procedure invariably producing less wasters (through flying, etc.) in the enamelling shop. It must be borne in mind that the enamel is made to suit an iron having definite physical properties, and any alteration in composition thereby affecting these properties—particularly the coefficient of expansion—must be avoided, otherwise crazing trouble will be experienced. It must, of course, be admitted that the composition of the enamel may be adjusted in order to produce one suitable for almost any class of iron, but the foundryman must remember that there are practical limitations in this direction beyond which it is not advisable to go. Further, for economical and successful production, it is essential that the two factors, *i.e.*, composition of metal and composition of enamel go hand in hand.

Preparation of the Enamel.

At the present time quite a large number of cast-iron enamellers prefer to buy the prepared enamels from firms who specialise in the production of this class of material. This practice is without doubt the best procedure, especially for small factories having a correspondingly small output. For larger concerns, however, having a substantial output it is probably a paying proposition to install the necessary plant for the production of their own enamels.

The enamel is prepared by mixing together such raw materials as quartz, felspar, soda, saltpetre, borax, etc., in the correct proportions by weight, and fusing the mixture in a frit furnace, the latter in older plants being of the coal-fired reverberatory type. In modern works, however, oil-fired frit furnaces are employed, which are not only more economical as regards fuel consumption, labour charges and output, but, far more important still from the enameller's point of view, result in the production of an enamel that is entirely free from small particles of carbonaceous matter, the presence of which is always a source of annoyance, resulting during the subsequent firing, in the production of unsightly blisters.

From the frit furnace, the molten enamel is allowed to flow into tanks of clean water which are stationed alongside the furnace. This sudden cooling results in granulating the frit

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* A Paper read before the Sheffield Section of the Institute of British Foundrymen, the Hon. J. M. W. North presiding.

and thereby making grinding much easier. Extremely soft, i.e., low-fusing point, leadless enamels as used for cast iron, should be removed from the tanks as soon as possible and immediately dried, otherwise decomposition may take place owing to the large amount of fluxing material (e.g., soda, potash, borax) present in such enamels.

Grinding the Frit.

The next stage in the process is the grinding of the frit into a very fine powder, suitable for use in the enamelling shop. This is accomplished in grinding mills, employing pebbles or steel balls as abrasives. The grinding operation may be conducted either "dry" or "wet," depending, of course, upon the type of enamel required, i.e., dusting or swill. Wet grinding, as the name implies, consists of grinding the enamel with the addition of water, together with clay and other additions for conferring certain physical properties on the enamel. Among these additions may be mentioned well-calcined magnesia (MgO) and Epsom salts ($MgSO_4$) which are used as vehicles, and without which the ground enamel would quickly settle to the bottom of any containing vessel, becoming a more or less hard mass, depending upon the degree of fineness to which grinding has been conducted. Other additions made at this stage are various metallic oxides and chemical compounds for increasing the opacity of, or imparting definite colours to, the enamel.

In dry grinding, the frit is simply ground to a fine powder by means of the pebbles without any water or clay addition, and generally without any metallic oxide additions, as these seriously detract from the gloss of the enamel. With enamels intended for dry grinding it is preferable to fuse any opacifying or colouring matter in the frit owing to the impossibilty of grinding by this method to the same degree of fineness as with the wet process. After grinding, the enamels are carefully sieved to exclude all unground portions or coarse material. They are then ready for use, better results being obtained from the swill enamels if allowed to stand for a few days.

Application of Enamel to Castings.

This is, or at least should be, conducted in a part of the works as far removed from the foundry as possible, in order to minimise the effect of dust and dirt, which always proves fatal to successful enamelling. In fact, to attain perfection it is essential that great care and scrupulous cleanliness be observed at every stage.

Before the final cleaning it is advisable to heat the castings (especially large ones) in the muffle until they have attained the temperature of enamelling. Although in practice this custom is not always adopted, it is important, because cast iron, after it has been cast into baths, sinks, lavatory pedestals, etc., will apparently grow—that is, enlarge, and remain permanently enlarged after the annealing. After once annealing, however, the size remains approximately constant. Such treatment also has the additional advantage of removing by oxidation any adhering carbonaceous matter remaining from the coal dust of the facing sand, which, if not thoroughly removed, will cause blistering and discoloration of the enamel. After annealing, the castings are thoroughly cleaned by means of a wire brush or pumice stone and well washed in order to remove any adhering sand, oxide, etc. If available, the ideal cleaning apparatus is a good sand-blast employing a rather coarse sand. Castings should be sand-blasted to that stage known in the trade as "white." Steel shot should not be employed, owing to the action it has of "peening" the surface of the castings. Neither should castings intended for enamelling be "bobbed," filed, or treated in any way that will give an extremely smooth surface, as a slight roughness gives a much better grip to the enamel, which adheres more firmly on a roughened surface. After cleaning, care must be taken that the castings are not handled with greasy fingers. When thoroughly clean, the articles are ready for enamelling, which operation may be conducted by means of (*a*) the dusting process or (*b*) the wet or swilling process.

Dusting Process.

This is the older process of the two, being in operation before the year 1840, and consists essentially of heating the object to redness in the muffle furnace, withdrawing it and, whilst still red-hot, dusting upon it the finely-powdered enamel by means of a long-handled sieve until the necessary thickness of coat is obtained. The coated object is again placed in the furnace until the enamel attains a glossy surface or is "run up," as the enameller calls it. Sometimes a first coat, ground mass, ground enamel, grip or glaze (different names for the same material) is employed, and consists essentially of an enamel of higher fusing point than the cover enamel; it is always employed as a swill. This glaze is free from metallic oxides and cryolite, and may be applied either by swilling, spraying or, in some instances, by means of a wide brush.

The glaze is now allowed to dry naturally in the warm enamelling shop, and on no account must the article be put into the muffle before the glaze has become dry, otherwise it will flake off or frizzle. When this coat is dry the article is put into the muffle, the temperature of which should be about 900 deg. C., until it assumes a glossy appearance. Great care must be taken not to overburn this coat, otherwise it will sink into the iron and not serve its purpose as a grip. When glossy, the article is withdrawn, and dusting proceeded with, as explained above.

Some cast-iron enamellers prefer to use a so-called "flux" as a first coat, consisting essentially of a very thin coat of an enamel slightly hardened by means of powdered quartz. This gives the iron a glaze upon which the cover enamel is dusted on as usual. Castings enamelled by the dusting process present a beautiful porcelain appearance, but there are several disadvantages to the process, among which may be mentioned the following: (1) The enamels used, especially for cast iron, must be of relatively low fusibility; (2) owing to the low output per furnace and the use of skilled labour, the method is expensive, and (3) the method is wasteful of enamel.

Wet or Swilling Process.

As indicated earlier, enamels for use by this method are in a liquid condition and applied to the cold castings either by swilling or spraying. At least two, and occasionally three, coats are required to give a good finish to the goods. Two kinds of enamel are always used, namely, a first coat and the cover. The first coat employed differs from that used in the dusting process, and is of the type known as a refractory first coat. This is prepared by fritting (not fusing) a mixture of quartz sand or flint with borax in the muffle furnace, and allowing the mass to cool in the containing vessels, the latter usually consisting of shallow pans smeared both internally and externally with clay. When cool, the mass is broken away from the vessels and is ground, together with further additions of quartz, clay and water, until the desired consistency, i.e., a thick cream, is attained. In this condition it is applied by means of swilling, spraying or any other method to the thoroughly-cleaned castings, which are then allowed to dry. When dry, they are run into the muffle furnace, which should be at a temperature of about 900 deg. C., and allowed to remain until they become red-hot. The castings are then withdrawn and allowed to cool. It should be pointed out that the first coat in this instance will not have fused, but simply become sintered or matted together, and, instead of having a glossy surface, will have a dull, porous or "biscuit" appearance. When cold, the surface is thoroughly moistened with water and the liquid cover enamel swilled or sprayed on. This is allowed to dry, and is then fired until glossy, withdrawn and allowed to cool in a place free from drafts.

By employing this method, hard, high fusing-point, acid-resisting enamels may be used, which would be extremely difficult, if not impossible, to apply by the dusting process. Such enamels are far more durable and highly resistant toward acid attack, this in itself being a decided advantage over the soft dusting enamels, which are, owing to their composition, very poor acid resisters, and often disintegrate under the action of moisture alone. In addition, the process has the further advantage of being a cheaper method of production, for less skilled labour is required; in fact, girls coat quite a number of the castings. Further, there is a greater output per muffle, as the articles may be fired in batches instead of singly. On the other hand, the value of having every individual casting handled and coated separately by a skilled workman must not be under-estimated.

New Methods.

A recent modification of the wet process has been introduced for use when cast iron is required to be enamelled at a low temperature, in order to prevent warping and especially where the castings must fit afterwards, without requiring further machining. Gas cookers, grates and similar articles are now largely enamelled by this method, which consists essentially of spraying the castings with the enamel, allowing them to dry and then running them into the muffle, the temperature of which should be from 700 to 760 deg. C. It takes about twelve minutes for the enamel to "run up" or mature as it is sometimes called. The castings are then withdrawn and allowed to cool; in the majority of cases they are finished articles. Should, however, a casting be insufficiently dense or opaque, or contain flaws, it may be re-sprayed, dried and fired again. In fact, the operation of coating, drying and spraying may be repeated several times in order to obtain any desired effect.

These enamels have a fusing point of about 700 deg. C., are free from lead and employed primarily for two purposes:—(1) To give an even coat of either white or black, and (2) to give a mottled white on black.

To produce the mottled effect now so popular, the sand-blasted cast iron is sprayed with the black enamel, dried, fired, cooled and then mottled with white enamel by means of a sponge or brush. When dry it is re-fired. To ensure success by this method it is essential that the castings be carefully and conscientiously sand-blasted. Further, the castings should not be handled by greasy or dirty fingers. Another important point is to see that the muffle is not too hot, otherwise blistering is bound to take place. In practice it has been found far safer to work at a lower temperature (700 deg. C. max.) even though the enamel may require a few minutes longer to mature.

Majolica Effects on Cast Iron.

No Paper, however brief, dealing with the subject of enamelling on cast iron, would be complete without some reference to the methods employed in the production of the so-called imitation majolica. The enamels used belong to the transparent class, and are always applied by dusting on top of a white enamel, whilst the latter is still hot. Upon this white enamel they melt and produce the beautiful effects that are always admired by everyone who sees really good examples of this class of work. Such enamels usually have a fusing point of about 600 deg. C., and as they are only employed for decorative work, generally contain a large amount of lead oxide (PbO). It is imperative that the majolica enamel has a lower fusing point than the white upon which it is to be applied, otherwise, instead of flowing over the

(*Concluded on page* 129.)

Cupola Malleable Cast Iron.

By H. H. Shepherd.

(*Concluded from page* 109.)

Melting Practice.

The most important factor governing the success or failure in the manufacture of cupola malleable is the composition of the metal, and it is clear that, in order to produce a uniform product, the composition must be as close as possible to consistent uniformity, especially in view of the small variations that are permissible. Now it has long been accepted that the one big failing of the cupola is that the production of uniform composition metal throughout the melt from day to day is a problem which, by the very principles of cupola melting, is an extremely difficult one to solve. Many say it cannot be done. The securing of absolute uniformity is certainly impossible, but the author has been agreeably surprised how near it is possible to get to uniformity by very careful control of all operations appertaining to the melting practice and to maintain this uniformity in composition throughout melts of from 15 to 30 tons per day,

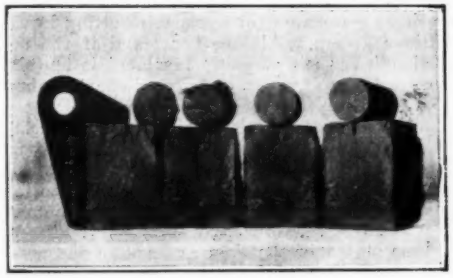

Fig. 8.—Showing the Type of Test-bars cast for the Routine Control of Composition.

once a standard practice has been established and rigidly maintained. It is possible to control silicon and manganese variations to less than 0.10 per cent. Total carbon varies more than the other elements, but again, by proper control, the wide variations can be confined to the first two to three charges of the melt and the last two or three.

Obviously, then, all material entering the furnace must be carefully weighed, and the guess-work measuring of coke, limestone, etc., involves failure initially. Moreover, it is essential to have a very reliable man in charge of this weighing.

In the following remarks regarding the cupola design and control, it should be pointed out that, although the author's firm is now operating Poumay cupolas, these have not been in operation long enough to express any reasoned views on them, and the remarks apply to the ordinary type of furnace.

The cupola operated by the author was lined to 32 in. dia. One of the essential details is to ensure that the diameter in that section comprising the tuyeres and melting zone is kept constant when patching each day. The inside diameter of the cupola should be such as to yield a tonnage that can be safely and satisfactorily handled by the shop, that is, to avoid having to hold the iron in the well for any time appreciably longer than is required completely to melt a charge of iron. In other words, tapping of the cupola should be made as soon as the charge is melted, as, obviously, the longer the iron remains in the well, the greater the carbon and sulphur absorption.

It is the author's firm conviction that the best iron is produced when melting is rapid, *i.e.*, when the cupola can be operated at normal maximum capacity. The term "normal maximum capacity" is used to avoid confusion with a "*forced*" maximum output at excessive pressures and volumes. The straight-lined—not boshed—cupola with one row of tuyeres having a ratio of 1:3 to 1:4 is preferred, and 3 to 4 tuyeres of the splayed rectangular type is recommended in preference to 8 or a dozen small tuyeres which slag up very easily and are apt to create small oxidising zones. Advantages and increased efficiency are obtained by having a generous distance between the base plate and charging door—14 ft. to 16 ft. is a good dimension.

The size of the well should be sufficient to hold at least one complete charge of molten metal and preferably two if the charges are small. The author prefers rather small charges of about 600 lbs. for a 32-in. cupola in preference to the large charges in the neighbourhood of 1,000 lbs. By using 600-lb. charges the well would be made to hold two charges, and much more uniformity results than would be the case with a 1,000-lb. charge, especially if the whole charge cannot be dealt with at one tap out. Further, in the writer's particular case, it was found that 600-lb. charges gave very hot metal and with the least amount of coke.

The Coke Bed.

One very important point necessary to good practice is the condition of the coke bed. To start a heat with a correct bed is half-way to obtaining a good melt all through, whilst an incorrect one causes trouble from the beginning to the end of the melt. It should be made up of good-sized, good-quality, dense coke. Small coke should not be used on the bed. The author recommends hand picking of the coke and selecting about 5-in. cubes. The amount of coke to put on the bed is measured by the height required above the tuyeres and not by weight. The required height will vary from 45 in. to 50 in. above the tuyeres, a greater height being necessary than for grey iron. The author is particular about the bed and personally sees it is level, is well burnt through before charging commences, and that it is of correct height. This is measured by a piece of conduit bent at right angles for a distance of 6 in. to 8 in. at one end and about 18 in. the other; the straight distance between the short right angle and the long one is equivalent to the distance between the point 45 in. to 50 in. above the tuyeres and the charging door.

Cupola Charging.

The charges consist of suitable pig-iron, steel scrap up to about 25 per cent., hard sprue and scrap, and a small percentage of annealed scrap, limestone and fluorspar, and the required amounts of ferro-alloys, as ferro-silicon, spiegeleisen or ferro-manganese. The amounts of these alloys vary from day to day and slightly throughout the melt. These alloy additions are necessary to aid the obtaining of uniformity of composition throughout the melt.

Charging of the cupola must be done with more than ordinary care if uniform melting and composition are to result. The order of charging is as follows:—(1) Steel scrap, (2) ferro-alloys, (3) pig-iron, and (4) hard and annealed scrap. Limestone and fluorspar, equal to 3 or 5 per cent. of the charge, are charged on the top of the coke of each charge. In addition, a charge of flux, equal to about 5.0 per cent. of the weight of the bed coke, is put on the top of the bed before charging commences. The amount of coke to each charge will vary with the type of cupola and methods of melting practice and control and, of course, quality of coke. The author has secured excellent results with an amount of coke equal to under 11.0 per cent. of the weight of charge, whilst an average would be 12.0 per cent. The good results were obtained when using a very good quality by-product coke, and where cupola malleable is concerned the author is emphatic about using a good-quality and dense coke. Buying coke at a saving of 3s. or 4s. per ton does not necessarily mean an ultimate saving; it may, in fact, result in a much greater loss.

Before putting on the blast the cupola should be charged full to the sill of the charging door and should be kept full up to the adding of the last one or two charges. This aids the maintenance of uniform conditions in the cupola.

The Air Blast.

The air blast is delivered by a fan and is adjusted by means of blast gate so as to give a pressure of approximately 7 ozs. in the wind belt. Such a moderate pressure, together with sufficient volume of air, is recommended in preference to high pressures. A constant of 130 cub. ft. of air per lb. of coke burnt per hour arrives at the amount of air required per hour, and this volume is measured by a "Campion" blast meter, which is a very efficient and

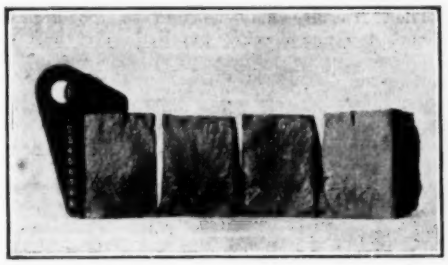

Fig. 9.—Chill Test-pieces used for checking Compositional Variations.

moderate-priced instrument for measuring the pressure and volume of air passing through the main. Careful control of the air delivered is necessary; excessive air will cause oxidised iron, but such condition is very liable to cause "hot" cracks to develop on solidification of the castings. In order to standardise the practice and to operate the blast gate under known conditions, a brass scale marked off in inches and quarter inches is attached to the gate body and a pointer is fixed to the handle and moves over the scale; this enables the gate to be shut or opened to a definitely known extent, which can be repeated from day to day by anyone controlling the cupola. Further, the gate is controlled throughout the melt in such a way that by the time the end of the melt is approached the amount of blast has been reduced to the correct quantity gradually, so that excessive wear on the lining and oxidised iron is avoided.

Tapping of the Cupola.

The old method of catching a shank of metal at the cupola spout at any time and in any quantity is done in many small grey-iron and malleable foundries, but certainly cannot be permitted when making cupola malleable. The iron is tapped into a mixing ladle set in front of the spout, and from this it is poured into smaller ladles, carried on monorails for distribution to various parts of the shop; the mixing ladle has a capacity of at least the weight of one iron charge. Tapping is done at regularly-timed intervals, which may vary from 4 min. to 5 min., except occasionally when towards slagging time tapping time may have to be reduced, but when slagging is finished the tapping time is properly regulated. A record is made of each ladle tapped, together with time of tapping, blast

pressure in belt, air volume, condition of iron and the position of the blast gate. The temperature of the iron at the cupola spout is approximately 1,400 deg. C.

Controlling Composition of Iron during Melt.

In cupola practice, one realises that it is not a satisfactory proposition to analyse samples of the iron during the melt and secure the results in a quick enough time to modify or adjust the charges to the correct chemical composition. Any changes required must be made quickly, and in order to do this a system of adjustment, according to fracture of test-pieces, similar to that largely used in air-furnace practice, is employed. From every other ladle, or, if necessary, from every ladle, a small round bar is poured, allowed to cool for a definite time in the mould, then removed and cooled in the air for a definite time, then quenched in water; the time from pouring to quenching being about 7 min. The quenched bar, shown in Fig. 8, is broken and the fracture is observed, and, if incorrect, then another bar is observed about 10 min. later, and if this still shows an incorrect fracture, the metallurgist can make the adjustments necessary, such as slight alteration in blast pressure, volume, amounts of coke or ferro-alloys, depending upon whether it is thought the incorrect conditions are likely to continue. It is of interest to note that a bar showing a very mottled fracture may be due to too high a silicon, too much coke, too little air, lack of proper mixing or tapping out; while an all-white bar can be due to the reverse of the first three causes given above or to the same last two causes. Experience and careful judgment alone must decide what is the most likely cause and the most efficacious remedy.

In order to have a somewhat more drastic test, a tapered test-piece about 5 by 1½ by 2½ in. taper is poured every few ladles, the moulds are made in such a way as to chill one of the

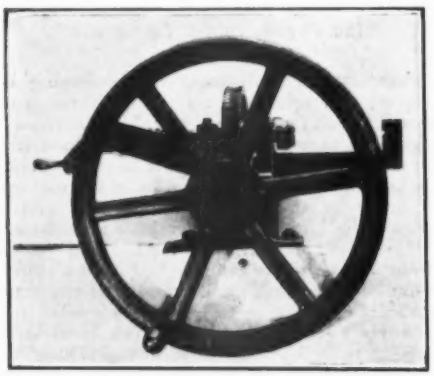

Fig. 10.—Torsion Testing Machine for Malleable Castings.

shortest faces of the bar, one side of the mould being formed by a cast-iron chill. These chill pieces, shown in Fig. 9, are left in the sand for a definite time, quenched in water, fractured, and the depth of chill measured. In this way information is obtained similar to that obtainable from fracturing the small bars, but the advantage of the chilled piece is that it is more reliable and definite, but the small bars are a valuable intermediate test. At the same time as a chill test is poured, and from the same ladle, a small bar as described above, a pair of tensile bars, torsion test-bars, and a block 3 in. to 4 in. cube are also cast. The last named is drilled after cooling normally and the drillings analysed. The number of chill tests and other bars will vary according to the amount of metal melted per day, a set being poured from about every six or eight taps, while the additional small bars are cast from alternate taps.

Tensile Bars.

The size of the bar is in accordance with the dimensions laid down in the B.E.S.A. Specification No. 5,022 for black-heart malleable iron castings—that is, the bars have an 8-in. overall measurement, a diameter over the 2-in. gauge length of $\frac{5}{8}$ in. gives an area of 0.3068. As these bars are tested without machining, the diameter, and, in consequence, the area, of the bars varies a little. The average ultimate tensile strength obtained is 19.6 tons, with an average elongation of 10 per cent. on 2 in. It should be pointed out that all bars required for physical

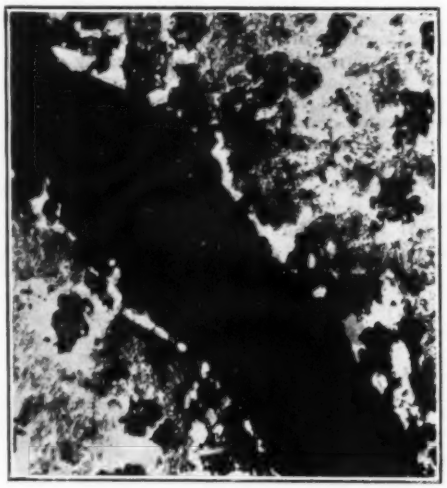

Fig. 11.—Microstructure of Partially-annealed Malleable. × 100 dias.

testing are marked when moulded in such a way that the date when cast and what part of the melt they were made can always be referred to. The yield point is not regularly determined, but is equal to 65 to 70 per cent. of ultimate strength.

Torsion and Twist Test.

This is not an official test. It is used purely for making comparisons of the toughness and ductility of the iron. The bars measure 6 in. long and $\frac{7}{8}$ in. thick. They are tested in the machine illustrated in Fig. 10. The test result being recorded as a percentage of 360 deg., the scale in the machine is marked off into 100 divisions. Average tests show 90 per cent. of 360 deg., while tests exceeding 100 per cent. are common.

Annealing.

The operation of annealing may be divided into two stages, the first stage consisting of heating to and maintaining at a given temperature for a given time period. This operation brings about the first stage of graphitisation, that of graphitisation of the free cementite. This results in the destruction of hard state of the metal, but it does not result in an annealed product. For example, if after this first treatment the castings are removed from the oven and cooled very rapidly they would still retain a considerable amount of their original hardness, hence the need for and importance of the second stage of annealing or graphitisation. This stage takes place after the oven is sealed, *i.e.*, it occurs during the cooling down. Whilst it is recognised that it is possible to anneal white or hard iron by heating to and maintaining at a temperature just above or on the critical or Ar. 1 point of the metal, the time that would be required, in the region of 200 hrs. or more, renders it valueless commercially, and, therefore, a first stage at an appreciably higher temperature is employed to hasten graphitisation, but this does not lessen to any extent the importance of the second stage. Actually, this is the most important stage of annealing, especially if one is keen to produce a good malleable casting. The first stage will bring about partial graphitisation, and graphitisation will also continue during the cooling to the Ar. 1 point.

The second stage is to bring about almost complete graphitisation of the carbon, or, to be more precise, the graphitisation of the eutectoid cementite or pearlite, into annealing or temper-carbon and ferrite. Now the ultimate graphitisation can only be completely successful if the castings cool down at a very slow rate through the critical temperature range, the critical temperature being in the neighbourhood of 730 to 740 deg. C.

The rate of cooling should not exceed 7 deg. C. per hour from 850 deg. C. to the critical point and through the critical range to 680 deg. C. it should not exceed 4 deg. C., and preferably not more than 3 deg. C. per hour. Any attempts to rush the cooling through the second stage or critical range will result in an only partially-malleablised product which will tend to be brittle due to the presence of considerable quantities of undecomposed pearlite. Such partially-annealed castings would show under the microscope what is sometimes referred to as "bulls-eye" structure, consisting of nodules of temper-carbon surrounded by ferrite and pearlite. Such a structure is shown in Figs. 11 and 12.

When the critical temperature is reached an exothermic reaction takes place, resulting in the castings giving up latent heat, and if the annealing ovens are correctly insulated it is quite possible for the temperature-record chart to show a straight line for some few hours, due to the latent heat given up by the castings balancing the heat radiated from the oven. The critical range lies between 700 and 720 deg. C. This is not the true critical range, but is due to lag between temperature of castings and that of oven atmosphere, which the pyrometer registers, as it is placed in the oven and not in the pots. This allows of more easy manipulation and removal if the pyrometer "burns out" during an anneal. The pyrometers used are base-metal ones known as "Titan" thermo-couples and manufactured by the Cambridge Instrument Company. The average life of the couples is ten months; some last longer, but usually their life is very uncertain after this period and they are likely to "burn out" at any time.

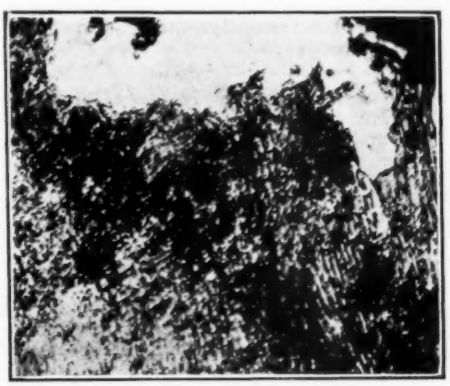

Fig. 12.—Microstructure of Partially-annealed Malleable. × 470 dias.

The temperature of annealing for the first stage of graphitisation of cupola malleable is appreciably higher than air-furnace malleable and ranges from 950 deg. C. to 970 deg. C. If the temperature is too high then the resulting temper-carbon will be large and very irregular in shape. The time of "soaking" may vary from 40 to 60 hrs., depending upon the composition of the iron, should this vary much for any particular melt. The average time of soaking will be 48 hrs. after the oven reaches "at-heat" temperature, which will require about 24 hrs.

In addition there may be a second soaking for a number of hours at about, or just above, the critical range. If for any reason an oven is deemed not to be cooling down sufficiently slowly the second cooling is done by refiring the furnace after it has cooled down to the required temperature. Too long a period of initial soaking results also in coarse temper-carbon, even though the ferrite be fine, or it may result in coarse carbon and coarse ferrite.

Annealing Practice.

After cleaning out and sorting, the castings are ready for loading into the annealing pots. Round pots are used in preference to rectangular ones, and the reasons for this are several. Round pots do not distort under heat so much as the rectangular, which is a distinct advantage, especially in the case of cupola malleable, in view of the comparatively high temperature of annealing. Further, round pots permit of better circulation of heat flames. The average life of a pot is 15 heats. The size is approximately 19 in. dia., 14 in. high and $\frac{5}{8}$ in. to $\frac{3}{4}$ in. thick. The top is flanged, and this aids supporting of the pots when building the tiers; it also acts as a support for the luting. For loading, the bottom pot is placed on a base which is mounted on legs, a little distance from the floor; this space permits the carrier prongs of the furnace loading-truck to pass under the base. Loading takes place at the sorting benches in the inspection department, and as each pot is filled another one is put on the tier until it is four-pots high.

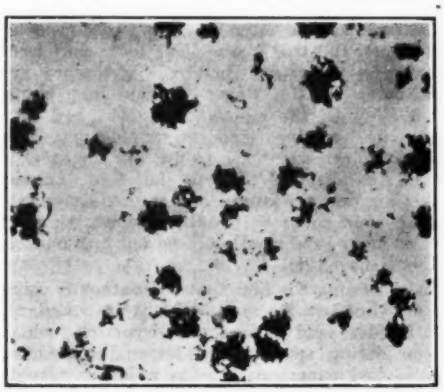

FIG. 13.—NORMAL MICROSTRUCTURE OF CUPOLA-MELTED MALLEABLE. × 50 DIAS.

At the present time no packing of any description is used, but between one pot and another is a lid which rests on the flange and so prevents the weight of the castings in the pot above creating distortion in those in the pot beneath. The joints of the pots and the joint between the lid and top pot are all carefully sealed. Care must be taken that the luting is of the right type and correctly done, so that as little cracking as possible takes place when the luting dries. If the luting cracks to any extent the castings become badly oxidised, and this is a serious fault, in particular if the castings require to be galvanised. The luting of pots is one of the most important points in dealing with "non-packed" annealing practice, and the writer has experimented with many types of luting. The most satisfactory results were obtained when a mixture of black sand and a strong loam was used. After luting, the tiers are loaded by means of a specially-designed truck.

The annealing ovens are also of a special design, unique in this country, and are the result of many years of experience of the parent company's engineers, who are constantly introducing improvements. The battery consists of four small ovens and one large oven at present, but one or two of the smaller ovens are to be extended shortly so as to have double their present capacity. The small ovens have a capacity of 20 tiers—*i.e.*, 80 pots—which contain in all 7 to 8 tons of castings. The large ones have a capacity for 14 to 16 tons of castings. All ovens are oil-fired, using a thin fuel oil and a special type of burner, also of the companies' own design, which is situated in the roof of the oven, one burner each for the small ovens and two for the large one. The burner extends through the roof of the oven, and is of such design that the oil flame can be adjusted to spray over the whole area of the roof by adjustment of the atomising air and oil and also of the dampers. A blue flame, which resembles an ordinary gas flame of a reducing character, is created and is controlled so as to fill the whole oven during the "heating-up" period. The flame is drawn down from the burner, circulates round the pots and passes to the stack by way of the flues in the floor of the oven.

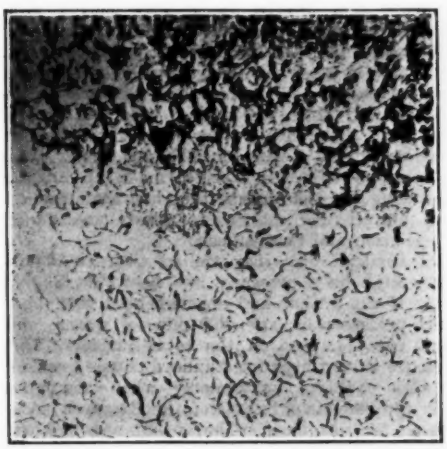

FIG. 14.—UNETCHED STRUCTURE OF FAULTY MATERIAL. × 50 DIAS.

In "non-pack" annealing, it is essential to maintain, as long as possible, a reducing atmosphere, otherwise oxidation of the castings will take place. The writer believes that the subject of reducing atmospheres and their effect upon the annealing of white cast iron to produce malleable cast iron is being given a great deal of attention by some authorities, and it has been shown that gaseous mixtures of carbon monoxide and carbon dioxide, such as one seeks to obtain in the annealing oven, does have an influence on graphitisation and that the action of the gases is a catalytic one, which takes place between the gases and the carbon compounds present in the iron, and the greater the CO content the greater the rate of graphitisation. However, there are other authorities who state that graphitisation is effected by means of the catalytic action of free-carbon oxides present in the iron causing a nucleus of temper-carbon along the boundaries of the cementite. On the other hand, some claim that the reaction is a direct chemical one, but up to the present there is no absolute proof that either of these theories is correct. It is, however, realised that the condition and composition of annealing-oven atmospheres do exert an important influence.

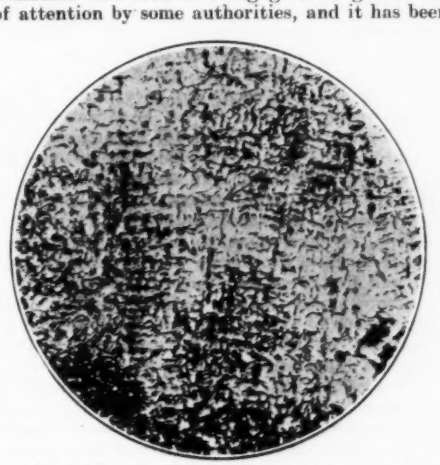

FIG. 15.—AS FIG. 14, BUT ETCHED WITH PICRIC ACID. × 25 DIAS.

Temperatures are automatically recorded by base metal couples which pass through the brickwork and extend into the back of the oven about 2 ft. The temperatures of the front of the ovens are controlled by means of Fery pyrometers focussed on the pots. It is easily possible, by correct adjustment of the flame, to maintain a practically uniform temperature (within 10 deg. C.) throughout the whole of the oven once it has reached "at-heat" temperature.

Inspection and Sorting.

After annealing and unloading, the castings are tipped from the pots on to sorting benches for further inspection and sorting, and it will be noted that they have a very thin and uniform coating of iron oxide which gives to them a pleasing blue finish. This blue skin is a direct indication that luting has been carried out correctly. Oxidised castings are occasionally obtained when the luting has been faulty or a pot has cracked or burnt through, but careful attention is paid to these points in order to avoid any undue oxidation of the castings.

FIG. 16.—SHOWING THAT THE DENDRITES OF FIG. 15 CONSIST OF PRIMARY GRAPHITE. × 100 DIAS.

In order to keep a constant control on the quality of the product, in addition to the ordinary chemical analysis, mechanical tests and metallographic examination tests are made on actual castings, one casting being taken from every pot and submitted to a workshop test, which consists of hammering with a sledge until fracture takes place. As a further aid to control, the annealing-oven men are furnished with a rough plan of the oven, ruled so as to show the position of each tier of pots, which are marked on the chart in alphabetical order and also with the date when the castings were made; thus, if unsatisfactory annealed castings are found, it is easily possible to ascertain when they were cast, so that reference can be made as to metal analysis or any other information which may help to explain the cause of trouble and to correct the fault.

Further Treatment.

Following unloading, inspection and sorting, the castings pass through straightening machines to correct any little deformation in shape that

may have taken place. They are then ground where the runners and feeders have been, and after rumbling to obtain a bright finish, are passed to the machine shops. It may be mentioned at this juncture that the screwing or tapping speed varies from 45 ft. to 60 ft. per minute, depending on the size and type of fitting. The screwing or tapping includes roughing and finish, the whole being carried out in one operation.

The speed for facing and turning, including roughing and finish of flanges up to 10 in. dia., averages about 120 ft. per minute.

The photomicrographs illustrated in Fig. 13 *et seq.* are representative of the structure of cupola malleable cast iron produced under the author's control. The magnification is × 50. It will be noted that the temper-carbon is not so nodular as in the case of air-furnace malleable.

Figs. 14 to 16 illustrate a rather interesting case of failure. These are photomicrographs of a specimen cut from the band of a rather heavy-section fitting which was poured at a time when the composition of the metal was not suitable for this type of casting, owing to danger of mottled or grey iron forming. After annealing it was passed to the straightening operation, and during this a crack developed in the throat of the casting very close to the band. On breaking up it was found that the fracture near the throat and bands was that typical dull grey fracture of metal which is mottled or grey in the hard state. Fig. 14 shows the unetched structure at a magnification of 50 dias., and it will be noted that no temper or annealing carbon was present, the free carbon being entirely graphitic. The specimen was then etched in picric acid, and it will be seen from Fig. 15 that except at the edge of the casting there is no appreciable quantity of pearlite, but the graphite is greater or more pronounced in some areas than others. Attention is drawn to the apparent dendritic formations shown in Fig. 15. In order to examine these peculiar formations, a magnification of 100 was used, and this revealed that the so-termed "dendrites" consisted almost entirely of primary graphite, shown in Fig. 16. The author is indebted to the British Cast Iron Research Association, and especially to Dr. Norbury, for the explanation of this phenomena, which is that the different graphite structures are, in all cases, primary graphite deposited direct from the metal when the casting solidified, the large flakes being normal graphite and the fine clusters "super-cooled graphite"; super-cooled graphite being deposited from areas free from graphite germs and normal graphite from those containing them.

In conclusion, the author desires to express his sincere thanks to his firm, Messrs. Crane-Bennett, Limited, for their very willing permission to publish the information contained in the Paper and the illustrations.

Discussion.

The Branch-President (Mr. A. F. Gibbs) asked the author three questions. First, what was the grain size of the core sand he used? Secondly, it was stated in the Paper that the tuyeres were splayed. Were they splayed downwards or upwards? He was rather inclined to think that these rectangular tuyeres were splayed downwards. Thirdly, what was the grade of the coke used and the chemical composition? As far as the silicon content of the metal was concerned, would the author regulate this according to the cross-section area of the casting? It seemed to him that in the case of a fairly thick casting the silicon content should be on the low side, compared with a very thin casting.

Total Carbon Content.

Mr. C. H. Kain said he had been greatly interested in the Paper, because he had had an opportunity of visiting the foundries of the International Harvester Company at Roubaix, where cupola black-heart iron was also made, and, in view of the information he had gathered on that occasion, he was rather amazed at one or two statements made by the author. For instance, the total carbon of 3 per cent. mentioned appeared to him to be abnormally high for black-heart iron, even for cupola black-heart, and was very high indeed as compared with ordinary air-furnace or electric-furnace metal. At Roubaix they worked consistently with a total carbon of 2.55 per cent. The chemist at Roubaix had shown him the routine analysis book, and from this it was clear that they had maintained this percentage with remarkable regularity. He also noticed that the author used pig in his mixture. At Roubaix they worked constantly and successfully with a 100 per cent. steel mixture, or sufficient steel to make up for the castings. In other words, they had their re-melt plus an all-steel charge, to which was added spiegeleisen and ferro-silicon.

At Roubaix also they melted with an abnormally high blast pressure, and he would like to know if the author had experimented with high blast pressures of, say, 600 mm. of water, and what effect it had on the total carbon? This pressure is very high for standard cupola practice in this country, particularly when compared with the recommendations of the Research Association for soft blast. The author also had the high tuyere ratio of 1:3, but the cupola which was working at Roubaix had a tuyere ratio of 1:10, which, perhaps, was to be expected, having regard to the high blast pressure used.

The results claimed for the metal made at Roubaix were 25 tons tensile and 13 to 14 per cent. elongation, and, again, he had been shown the test-books to prove this, and these figures were maintained with great regularity. They fell below these figures sometimes—we all fell short of the best occasionally, but, generally speaking, these figures were maintained with very little difficulty.

Tapping Temperature.

Mr. W. J. Molineux said the author had mentioned a tapping temperature of 1,400 to 1,450 deg. for the cupola. That was fairly high, and many who were used to cast iron would have some difficulty in maintaining such a temperature. He himself had done it in making pearlitic iron and also Emmel iron, but it was not easy to maintain these temperatures. The author had a fairly deep well in his cupola and it would be interesting to know why. Again, why did the author have two charges in the well before tapping? It seemed that he would be more likely to keep his carbon and sulphur correct if he kept his tap-hole open and slagged from the spout. As Mr. Kain had said, the carbon of 3 per cent. was very high. Why did the author require to use ferro-manganese in his charge, because he should have thought—although he did not know what pig he used—that with a steel base and the pig mix there would be rather more manganese than would be required in the circumstances? It would, therefore, be interesting to have a little more information as to the charge which was used and what was found in the finished casting. Was the ground mass almost entirely ferrite and temper-carbon? There had not been sufficient explanation of that. Much criticism of the Paper had been anticipated by the author saying his product was not as good as air-furnace or electric black-heart malleable, and that was to be expected. The bars that had been passed round were very thin, and he believed white-heart people would easily obtain the same twist as was shown on these thin bars of black-heart. No doubt the product of the author was quite suitable for the type of casting made. Finally, he would like to know what are the variations in thickness the author can successfully make, free from primary graphite, with the rather wide limits of analysis mentioned in the Paper.

Shape of Runners.

Mr. J. W. Gardom said he had been very interested in the Paper, but, having made some malleable himself, he felt very loth to criticise. The author had not stated the annealing temperature and a whole lot of other things it would be interesting to know, but perhaps it was hardly fair to call attention to this, because very often, in giving a Paper of this nature, it was not desirable to say too much. The Paper stated that, from the metallurgical point of view, the author favoured rectangular runners, but, personally, he could not see the argument. The round runner washed away the sand very much more easily, and, in spite of careful grading, he regarded this as very important. Moreover, the round runner had the advantage of a greater surface area, and therefore of enabling cooling to take place more quickly. The author's remarks with regard to the advantages of having a smaller feeder were borne out by experience. It had been found that, by making the feeder small enough, a better result could be obtained. In fact, many malleable castings were made without any feeders at all. Would the author say how he filled his core boxes? The Paper said something about cores, but it was not stated whether they were blown, or rammed, or vibrated. As regards sand-core mixtures, the author stated it was better to use boiled linseed oil than any of the standard core mixtures. The principal reason for this seemed to be that it was cheaper, but how much did it cost the author to test the linseed oil which he bought, because it was essential to be certain that the iodine value was correct. At the same time, he had been assured that such a test was very difficult to carry out. He did not agree with the author in the use of cast-iron jackets, because they were heavier than steel, and that was a point to be considered in a mass-production foundry. Reference was also made in the Paper to shovelling facing sands. With the advancement that had been made in foundry sand, he would not have thought it necessary now to use any facing sand at all, let alone to have to shovel it. In any case, this was a wasteful and unproductive job. Facing sand could be handled in just the same way as other sand, and could be fed into buckets without shovelling.

In criticising the fact that the author is using a method of test for sand which is not standard, Mr. Gardom said he is on the committee which is considering specifications for malleable iron, and it had experienced quite a lot of trouble through people taking a standard specification and applying it to their own particular needs with a little alteration. Perhaps it was sufficient for him at the moment to say that the tests are not standard, and that therefore the results obtained are not comparable.

Annealing and Composition.

Again, he did not agree with the suggestion of the author that the annealing of white-heart can cover the faults of chemical composition. Even a white-heart-iron manufacturer could use fairly large furnaces and turn out large quantities, and if there was an annealing furnace containing 15 to 20 tons of work, it would be quite impossible to cover the varying compositions in that same furnace and get a good result. It was quite as essential with white-heart manufacture to have a good composition as it was for the particular class of iron of which the author had been speaking. Indeed, white-heart manufacturers had held their composition within the close limits which had been mentioned in the Paper. Previous speakers had objected to certain aspects of the composition of the material manufactured by the author, and the point was explained, perhaps, in what the author had said as to annealing covering any variety in the composition. What the author really should have said was that, given a certain composition, it was possible to adjust the annealing to cover that composition and turn out a satisfactory article.

With previous speakers, he did not like the high carbon mentioned in the Paper, whilst the

silicon also seemed to be on the high side, but that was balanced by the high sulphur. Again, the manganese was rather on the high side to give the very best results in black-heart. Then the author had said that the phosphorus should not exceed 0.2 per cent., but he did not think it would ever reach that, seeing that the majority of malleable was below 0.1 per cent. It was an advantage to keep the phosphorus down, although if the phosphide eutectic was at all pronounced there was very little effect from a higher percentage of phosphorus.

As to the "as-cast" metal with 75 per cent. pearlite and 25 per cent. free cementite, was the author able to give any definite method of estimating the percentage of pearlite and the percentage of cementite in the "as-cast" and also in the annealed specimens? The reason he asked that question was that the Committee, to which he had previously referred, and of which Mr. Kain and himself were members, was considering putting forward the possibility of a microscopic specification. He hoped that anything he might say in this connection would not be taken as official, because, as a matter of fact, they were almost afraid to mention it. One of the essential things in the final work of this Committee was that manufacturers should agree as to what they were aiming at in regard to the percentage composition of pearlite and ferrite in the finished article, and, therefore, it was essential that there should be some definite method of testing it and agreeing that the result was correct. If, therefore, the author could give any information on that matter, the Committee would be assisted in going forward with its report.

As to the charge, the Paper mentioned 25 per cent. steel scrap, together with ferro-alloy and other things, but he did not like the idea of using ferro-alloy. The Paper contained many remarks on the careful control of all the conditions concerning the cupola, but 5 or 6 per cent. of ferro-alloy into a small charge of 600 lbs. seemed to suggest that it was not being thoroughly mixed, and he was wondering if that was the reason why the author held up so much material in the well of the cupola, which was again put into the mixer.

Author's Reply.

In reply to Mr. Gibbs' query as to the size of core sand, 60- to 80-mesh core sand is found to be most satisfactory. Tuyeres are splayed in each direction. The coke used is a Welsh by-product, one having a sulphur content of not more than 0.5 per cent. and an ash content of approximately 6 per cent. With regard to the silicon content suitable for various sectional thickness, the heavier section castings are poured with the rather lower silicon iron, round about 0.7 per cent.

In reply to Mr. Kain's remarks suggesting that a total carbon of 3 per cent. was high, it should be pointed out that this is the total carbon resulting from ordinary cupola practice. The author of the Paper readily admits that the International Harvester Company of France do produce a very much lower carbon metal, but Mr. Kain omitted to mention that they use receivers in conjunction with their cupola, hence the lower total carbon. Such practice also enables them to use considerable quantities of steel.

Replying to the various points raised by Mr. Molineux, the tapping temperature of the iron is, for the ordinary cupola practice, possibly nearer 1,400 than 1,450 deg. C. Ferro-alloys are added direct to the cupola for the purpose of making slight adjustments in the composition. If these are added to the charge in the correct way, quite satisfactory mixing results. In addition, if necessary, alloy additions are made to the mixing ladle. The etched structure of cupola black-heart malleable shows temper-carbon and ferrite grains with a small amount of pearlite. The quantity of pearlite is rather more than is found in air-furnace metal. Mr. Molineux raised a point that the author did not mention the silicon contents suitable for the metal; this is one of the points that was omitted when hastening through the Paper, as pointed out above. The silicon content is given in the Paper and it ranges from 0.7 to 0.8 per cent.

In reply to the many points raised in Mr. Gardom's very keen and interesting discussion, the pig-iron used comprise one or two brands of hematite iron and two brands of refined iron. In answering his criticism for the writer's preference for rectangular runners, he pointed out that the runner angles are not really sharp, but, for many jobs, a sound casting has resulted when changing the runner from the half-round to the rectangular. It may be that it is not suitable for all classes and types of malleable castings. Mr. Gardom said that no information was given as to how the cores were made. It was certainly pointed out that the cores were made in iron core boxes. It was later mentioned in the Paper that it was not "proposed to describe in detail the various routine stages in production," as these operations could be seen when the Branch members visited Ipswich. As to the cast-iron jackets being heavier than steel, this was so, but since only half a dozen or so were used in conjunction with all moulds made by one machine, as described in the Paper, the question of weight of the jacket does not become a serious factor and their longer life and easier adjustment completely outweigh the disparity in weight.

With regard to the criticism of the methods of testing, the author pointed out that the B.E.S.A. tensile test was adopted. As regards the torsion test which was referred to, it was largely a workshop one for determining the results of annealing quickly. If the author can be of any help to Mr. Gardom in connection with his efforts, as a member of the Standards Committee, to set down and encourage the use of standard methods, he will be very glad to do so. He believed it was Mr. Gardom who raised the point that the annealing temperature had not been mentioned. This is another important item which was overlooked, but it was given in the text of the Paper.

He thought the above covered all the points raised in the discussion, but should any have been omitted, he would be happy to reply in writing.

The Vitreous Enamelling of Cast Iron.

(*Concluded from page* 124.)

white, it will simply sink in, with the production of a mottled instead of the transparent-coloured glazed effect desired.

To obtain a true-black vitreous enamel, however, the powdered black enamel is dusted directly on the first coat, *i.e.*, without the white undercoat. When this type of black enamel is applied on a white one, a bluish grey is obtained, its colour varying according to the thickness of enamel applied. In some instances the black is dusted direct on to the hot casting.

The dusting of cast iron with powder enamels containing lead and often arsenic compounds, which undoubtedly have a highly-injurious effect upon the health of the workers, is to be condemned, and it is with pleasure one notes a growing tendency in the trade to work without lead as far as possible. Several instances can now be given of firms who have completely discarded lead-containing enamels. According to some experts, it is impossible to produce a good majolica enamel without the use of lead, but the author has successfully produced them with the most beautiful colours. One of the principal factors ensuring success lies in the careful selection of a white undercoat having a higher fusing point than the coloured cover enamel.

Publications Received.

The Iron and Steel Trades in 1930. Published by William Jacks & Company, Winchester House, Old Broad Street, London, E.C.2.

We invariably look forward to reading this annual review, as it is particularly well informed, as to both national and international movements. Moreover, the editor is not afraid of speaking his mind even to the extent of attacking well-entrenched interests. The policy of the Cleveland ironmasters in restricting output and maintaining price levels is severely criticised as being economically detrimental. The continuance in the use of small-production blast furnaces is depreciated. Yet we seem to have seen in the Cleveland area the very type of plant advocated installed, but out of action because the design was unsuitable for the lean type of ores economically available. However, we agree with the general principle as laid down in the brochure, because a study of the most recent statistics shows that the output of the furnaces of the Nottinghamshire, Derbyshire and Lincolnshire area have virtually maintained or exceeded their 1913 average yearly production.

In the section dealing with imports and exports, we noticed, with some surprise, that there is no table showing the countries of origin and the amounts received by way of pig-iron imports. The amount received from India is now of serious importance, some details of this would interest the foundry world. However, it is impossible to cover every aspect, and undoubtedly this is a particularly clever and well-informed review.

The Economic Utilisation of British Pig-iron Resources, by C. H. RIDSDALE and N. D. RIDSDALE. Published by the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester. Price 1s. 8d. post free.

This pamphlet, which is a reprint of a Paper presented at the last conference of this body, is an extremely valuable contribution to the scanty data available to the foundry industry. It contains a very complete list of the pig-irons manufactured in Great Britain, together with their composition and type. The modern iron-foundry foreman who is called upon to make castings to analysis will find this list indispensable.

Catalogues Received.

Gas and Coke.—Carrying a very striking cover and bearing the caption "The Harnessed Flame," the Gas Light & Coke Company, London, have certainly produced a most interesting brochure. On page 7 we are shown that 1 ton of coal, when handled by the issuing firm, produces in the form of gas 8,400,000 heat units, whilst a modern electric generating station only 6,000,000. So far we agree, but we cannot endorse the claim that this gas process yields only 80 lbs. of ash as against 224 lbs. when generating electricity. We suppose the "catch" is that the ash left in the coke is somebody else's "pidgin." Apart from this, the booklet makes quite interesting reading.

Conveyors.—The Steel Band Conveyor & Engineering Company, Limited, Barker Street Works, Parade, Birmingham, has prepared a folder which illustrates a number of installations this firm has made, incorporating the use of steel-band conveyors. Two of these are foundry applications, one for handling cores and the other foundry sand. A price list is included, which shows some price reductions have recently been made.

MESSRS. SCOTT'S SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Greenock, have received a contract to build a turbine-driven passenger steamer for London owners.

Some Notes on Storekeeping.

By Eric N. Simons.

Dealing with Scrap.

All saleable scrap should be forwarded to the storekeeper, irrespective of the department that has produced it. It should be weighed and sorted by the stores and kept in convenient or safe places until such time as arrangements can be made for its sale or delivery. In some stores a separate room or division is kept for scrap, and here such lots as need to be locked up or protected can be so dealt with. All will depend, so far as this is concerned, on the size of the stores itself, and the amount of available storage space that can be devoted to extraneous commodities. On receipt of a consignment of scrap for disposal, the storekeeper should notify the buying department on a form. It is then the buyer's task to find a favourable market for this material, and to give the storekeeper, ultimately, instructions for its disposal. He should also instruct the accounting department to credit the works department concerned with the value of the scrap received into stores and sold, and the accountant should send to the department an official credit note showing the requisite allocation details.

Importance of the Margin of Safety in Storing Materials.

In any rational system the stores has a record of maxima and minima, and as soon as the minimum quantity is reached, the storekeeper sends the buyer a requisition for the amount required, to bring the stock into the proper state. A note must be made here, however, to the effect that, in some instances, there is no standard maximum or minimum, so that the storekeeper is unable to send the buying department specific requisitions for goods. In these instances he notifies the buying department on a proper form that what he considers the minimum has been reached or is in danger of being reached. The buyer then purchases whatever amount he thinks it advisable to purchase, his decision being governed by past records, the state of the market, the current condition of trade and the extent to which goods can be stored or consumed. Wherever these discretionary powers belong to the buyer—and to some extent they so belong in every manufactory or firm, since there are always some commodities whose consumption fluctuates to such an extent that maxima and minima cannot be accurately estimated or prescribed—he must exercise great care to ensure that his purchases are economical. The economics of buying—a phrase that the buyer must not allow to frighten him in his endeavour to master his profession—demand the strict observance of the margin of safety in all purchases. In other words, while stocks must never be higher than is consistent with minimum deterioration and capital expenditure, they must be high enough to preclude any possibility of shortage, resulting in a hold-up of production, assembly or other operations connected with sales. To fulfil these requirements, the buyer must, therefore, make himself thoroughly familiar with the following factors in regard to any single commodity:—(1) The normal rate of consumption, (2) the potential rate of consumption over the period that the order is intended to cover, (3) the time that will be required for delivery, (4) the amount that can be afforded and (5) the rate and percentage of deterioration over a given period.

Whilst this information is never without value, even when the goods are such as permit of fixed maxima and minima, with automatic requisitioning by the storekeeper, it is of prime importance when the decision as to what constitutes maximum or minimum at any given moment rests entirely with the buyer.

Fixing Maxima and Minima.

In some instances, the storekeeper is supplied with copies of orders received so that he may estimate in advance what goods are likely to be issued from stock over a given period and so prevent any unforeseen shortage. But this is not a plan to be recommended. In the writer's opinion, the work of fixing maxima and minima is not properly that of storekeeper, but that of the buyer, who may, of course, consult the storekeeper at his own discretion. The buyer should possess records ample enough to enable him to decide just how much of a specified commodity is likely to be used over a specified period and thus to fix his maxima and minima, which it is the storekeeper's duty to observe. In the fixing of these quantities the buyer will have to take into account factors of which the storekeeper will have no experience or knowledge, such as the state of the market, transport costs, influx of work and so forth.

Where the commodities concerned are such as fluctuate in demand according to the dictates of fashion or to the taste of the general public, the fixing of maxima and minima is not easy; but by collaboration on the part of the buyer, works manager and sales manager, a safe and economical figure can be reached fairly readily. The sales manager will be able to estimate what forthcoming sales will represent in the form of aggregate accounts; the works manager will, from what the sales manager can tell him, be able to say what quantities of different materials will be needed to produce the volume of goods that the sales manager expects to sell; the buyer will be able to say what quantities he can purchase on economical terms as the markets stand. In consultations of the kind it is necessary to take into account: (1) The period for which the plans are being made; (2) the time taken to deliver the material ordered; (3) the time needed to manufacture or produce the goods; (4) the time required to market them to the consumer. These factors will all affect the ultimate economies to be obtained by careful buying.

If an article or manufacture is likely to become unsuitable, or the demand for it will probably slacken, the maximum figure should be as low as possible. It must be remembered that sellers as well as buyers—sometimes more often than buyers—look ahead and strive to forecast the probable trend of events. When they see that a change in demand is coming, they often take advantage of their foresight to offer attractive lots of goods to buyers, hoping thus to get rid of surplus or existing stocks before prices fall. The unwary buyer who, under the impression that he is getting a fine bargain, plunges on these goods, not having guessed at the reason for the offer, will only too often find himself caught.

Where standard products, for which demand is regular, are concerned, it is not difficult to fix maxima or minima that shall be stable. In all other cases experience, good judgment, accurate and comprehensive buying records and intelligence will enable figures to be reached that will work well in practice, though they may need revision at regular intervals.

Qualifications of the Storekeeper.

The need for accuracy, patience, care and intelligence on his part has already been stressed. In addition to these qualities, he must possess method, a sense of humour, tact and loyalty. He will have it in his power greatly to facilitate or hinder the work of other departments with which his duties bring him into contact. In spite of his desire to maintain his systems and routines inviolate, there will be times when, to facilitate the operations of some producing or other department, he may have to introduce a little elasticity into his methods. He should know just when and where such elasticity is permissible, and just when and where it is expedient. At the same time, while he may occasionally wink at a variation from the orthodox procedure, he must not allow this variation to escape record. In other words, though he may sometimes have to issue stores without receiving a docket or requisition slip, simply because the urgency of a particular job demands it, he should make sure that eventually the docket comes to him for the purpose of keeping his records straight. No storekeeper with sense would, for instance, allow the red-tape of routine to prevent him from issuing a tool in a hurry, and without a requisition, to enable some unfortunate fellow to be freed from an entanglement in machinery; but only a slack storekeeper would refrain from either ensuring return of the tool after completion of the work or demanding a signed requisition for its retention when such a demand ceased to be unseemly.

In his relations with his staff he will have to be vigilant, tactful and just. However able his assistants may be, the ultimate responsibility is his, and no condonation of slackness on his part is possible, in view of the economic importance of his work. Every blunder or piece of neglect in the stores connotes an increase in the overhead item of costs, and a mere fractional addition to overhead costs may mean all the difference between securing and losing an order, a fact too seldom realised by those responsible for the many instances of waste to be found in British factories and workshops.

He should regard it as a point of honour to carry out the wishes and instructions of the buyer, when the latter is his superior; but he should never hesitate to make suggestions for the improvement of stores work, or for the better co-operation of his own department with the buying department.

Book Review.

Kurs Odlewnictwa, Tom. I, by Dr. K. Gierdziejewski.—Warsaw: Ksiegarni Technicznej.

This is Vol. I in a series entitled "Foundry Course," edited by the author, who is head of the Foundry Department of the Warsaw Technical High School. It deals with the subject of melting metals in the foundry. After a brief outline of the history of the foundryman's craft, the subject is dealt with in two main sections, in the first of which raw materials used in the foundry are discussed (metals, fuels and fluorspaths). Refractory materials are relegated to Subsection VI of Part II, the whole of this second part being devoted to furnaces for melting metals in the foundry (cupolas, crucible furnaces, Tropenas converters, reverberatory and electric furnaces). In the part dealing with reverberatory furnaces, the author discusses the late Prof. Grum-Grzymaylo's hydraulic theory as applied to steel furnaces, his references being to two Papers contributed by the originator of that theory to the "Russian Metallurgical Journal" as far back as 1910 and 1911, and to some articles in the American "Iron Age" (in 1922) and "Stahl und Eisen" (in 1923 and 1925). The Russian professor's book on his own theory, published a few years ago in French and English, has evidently escaped our author's notice. Of the four appendices one is devoted to calculations in connection with the use of producer gas, Tropenas converter heat-balance-sheets, a 30-ton open-hearth furnace and tables for helping heat and velocity calculations. The volume is fully illustrated. There are 157 illustrations in the text and three folding plates at the end of volume giving details of a cupola and the 30-ton open-hearth furnace dealt with in the text.

L. K.

The Properties and Applications of Metallurgical Coke.

At the January meeting of the London Junior Section of the Institute of British Foundrymen, Mr. L. H. Howell in the chair, MR. H. W. KEEBLE read a Paper upon the subject of metallurgical coke. The various processes of manufacture were clearly described with the aid of lantern slides, and the author went on to deal with the combustibility, reactivity and applications of coke.

Combustibility of Coke.

MR. KEEBLE said that the ignition temperature of metallurgical coke is between 500 and 600 deg. C. Beehive cokes usually have the higher ignition point. The combustibility of a coke is the term used to denote the rate or velocity at which the reaction occurs between the coke carbon and the atmosphere, under standard conditions. Combustibility is controlled by the pore structure and the allotropic condition of the coke carbon. Combustion of a fuel is dependent, amongst other factors, on the total surface area exposed to the oxygen, this in turn being dependent on the interconnection of the pores. It appears that a readily-combustible coke is one that is dense, *i.e.*, containing many fine interconnected pores per unit mass. The maximum temperature developed by coke combustion varies within the range of 1,500 to 1,800 deg. C. It is interesting to note that on a series of tests beehive coke gave the highest combustion temperature, it being 1,800 deg. C. In industrial applications, such as in the blast furnace and cupola, the average fuel-bed temperature is of more importance than maximum combustion temperature. To obtain a free-running slag in the blast furnace a temperature of 1,500 to 1,550 deg. C. is required. Therefore the fuel-bed temperature over a range of area is of more importance than a local area of high temperature. The size of the coke in determining the fuel-bed temperature is of importance. Small coke will produce a lower average temperature than will large coke, due to the heat-absorbing reaction of $CO_2 + C = 2\ CO$, although the maximum temperature of combustion will not be affected. The lower the shatter-test hardness and total porosity, the lower is the fuel-bed temperature.

Reactivity of Coke.

The reactivity value of a coke is the extent to which it is capable of reducing CO_2 to CO. An increase in temperature causes an increase in reactivity. Fig. 1 shows the reactivity curves for different kinds of carbon. In general, the lower the shatter-test index the higher is the reactivity value, or, in other words, soft, friable, easily-burnt varieties of coke have a higher reactivity than hard dense cokes. As a rule, the coke properties of combustibility and reactivity run in parallel, that is, a readily combustible coke is usually the more reactive with CO_2. The catalytic effect of iron and its compounds on the reactivity values of coke is most important. Iron in the coke ash may exist as ferrous silicate or aluminate of a complex nature, or in combination with oxygen as an oxide, or with sulphur as iron sulphide and it also may be present in the metallic state. Only when the metal is present as an oxide or in the metallic condition is there any effect on reactivity. With the former compound the effect is small, whilst with the latter it is large.

Analytical tests show that there is a relationship between the amount of active iron present in the coke and the reactivity curve obtained. The ash composition of the original coal is a controlling influence on the amount of active iron present in the final coke. Beehive cokes give lower reactivity values than do by-product cokes. The silicates, aluminates and iron-sulphide compounds are inert as far as their effect on reactivity is concerned. Prolonged heating may cause the conversion of the active iron into an inert state by combination with oxygen and silica to form their respective compounds. This probably is the explanation of the difference in reactivity values which exists between beehive and patent-oven cokes. The beehive process takes about three times as long as is necessary for the patent-oven practice. With this longer coking time the formation of the inert iron compounds would be greatly facilitated with their corresponding effect on the reactivity curve.

Applications of Metallurgical Coke.

Metallurgical coke is employed in crucible-steel melting, in brass melting, in blast and cupola furnaces and in other spheres, such as foundry core ovens.

The quality requirements of blast-furnace coke are that they should be able to carry the burden without crushing, form a minimum of slag and generate a high average fuel-bed temperature with a low fuel consumption. Translating these requirements into practice, it seems that the physical characteristics of coke are of more importance than its chemical constitution in attaining these conditions in the blast furnace. Considering the chemical analysis, the amount of moisture present is of more importance in the light of its increasing the weight of coke than it is in increasing the fuel consumption by requiring heat for its expulsion. Low-ash cokes are to be preferred. At a British works, the substitution of a 12.1 per cent. ash coke by one with 9.8 per cent. resulted in a reduction of 1 cwt. of fuel per ton of metal melted and an increased output of 15 per cent. The ash in the coke requires to be neutralised and melted to form a fluid slag. It is usually assumed that 10 to 15 per cent. of the total coke weight is necessary to fuse its own ash, according to the amount present and the basicity of the slag. The sulphur and phosphorus contents should be as low as possible.

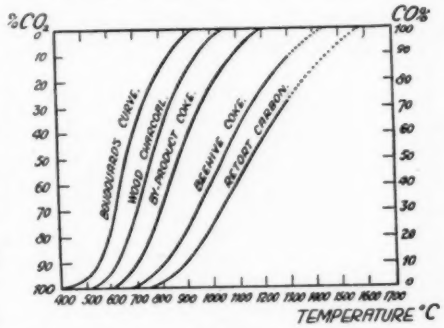

FIG. 1.—REACTIVITY CURVES FOR DIFFERENT KINDS OF CARBON.

The mechanical properties of coke have a preponderant effect on the blast-furnace operation. The coke should be hard (high shatter index), of uniform size and dense structure. The elimination of breeze is important, as its presence increases the resistance of the passage of the blast and is practically inert as far as heat-unit production is concerned. At one works, a sieving out of 10 per cent. of breeze resulted in a 20 per cent. increased output and an economy of 2½ cwts. of coke per ton iron melted. Referring to Fig. 1, it is seen that under equilibrium conditions at a temperature of 1,600 deg. C. all CO_2 has been reduced to CO, despite the differences in the original type of carbon. The hearth temperature of a blast furnace is above this point of 1,600 deg. C. Although conditions inside the furnaces are far removed from the equilibrium state, it is suggested that, in the light of the temperature development in the hearth, the reactivity values of coke are of less importance than supposed, and that the physical properties of hardness and size have a greater effect on the thermal-chemical conditions prevailing than does reactivity.

For iron melting in the cupola the dominant property desired is the ability to attain and maintain a high temperature economically. The function of the coke is to be burnt completely within the limits of the melting zone. Assuming the blast supply and pressure is correct, a coke of high combustibility is desired, that is, it must contain a minimum of closed pores and a maximum of interconnected cells per unit area. Soft friable cokes are useless in the cupola, as they promote excessive fuel consumption, due to it crushing down to fines. The absence of small breeze with uniform size appears best practice, it being adjusted to the cupola size. The ash content should be low and is generally specified to be under 10 per cent. Where the ash content is high, a well-developed tubular cell structure is of great importance, for if the coke mass is closed, that is, contains closed pores, the plastic ash will plug these pores and hinder combustion. The sulphur element should be present to the extent of not more than 1 per cent. Moisture is a hindrance to high-temperature generation in the cupola, as it requires heat for its evaporation as steam, and as this is accomplished above the melting zone, the formation of the water-gas reactions do not occur, as have been suggested by some. If coke does hold moisture in its structure until it reaches the melting zone, its sudden evolution at this point, coupled with the prevailing temperature, would most likely cause the collapse of the coke mass into fines, with consequent serious effect on the working of the cupola. The soft friable grade of coke appears to give a higher carbon pick-up than does hard strong coke.

Summarising the previous considerations, it seems that the best coke for the cupola will be one of uniform size, with an absence of fines, of dense structure, readily combustible and containing low percentages of ash, moisture and sulphur.

Mr. Keeble was thanked for his interesting Paper.

BIBLIOGRAPHY.

"COKE FOR BLAST FURNACES," Midland Coke Research Committee.
"REACTIVITY OF COKE," Parts 1, 2 and 3, Department of Scientific and Industrial Research.
"COKE." Cawood & Son.
"PRODUCTION OF FOUNDRY COKE," by A. E. Taylor. *Foundry Trade Journal*, April 18, 1929.
"APPLICATION OF AMERICAN PRACTICE TO THE BRITISH COKE INDUSTRY," by T. B. Smith, F.C.S. *Iron and Coal Trades Review*, December 18, 1928.
"COKE FOR CRUCIBLE STEEL MELTING," by R. Wheeler, D.Sc. *Iron and Coal Trades Review*, April 23, 1926.
"COKE FOR BLAST FURNACES," by Evans. *Iron and Coal Trades Review*, March 19, 1926.

Contracts Open.

Belfast, February 21.—Electrical stores, for the Electricity Committee. The City Electrical Engineer and General Manager, East Bridge Street, Belfast.

Horsham, February 16.—3½ miles of 14-in. and 2½ miles of 12-in. spun-iron main, etc., for the Urban District Council. Mr. C. G. Atkinson, engineer, Horsham Park, Horsham. (Fee £3 3s., returnable.)

Ickleford.—330 yds. of 3-in. water main, for the Hitchin Rural District Council. Mr. A. E. Passingham, clerk, 9, Bancroft, Hitchin.

Whittlesey, February 18.—18 miles of 8-in., 6-in., 5-in., 4-in. and 3-in. cast-iron water mains, etc., for the Urban District Council. Mr. G. B. Kershaw, civil engineer, 9, Victoria Street, Westminster, S.W.1. (Fee £5, returnable.)

Winchcomb, Glos., February 16.—3,000 yds. of 4-in. cast-iron water mains, for the Winchcomb Rural District Council. Mr. H. W. Stephens, clerk, High Street, Winchcomb. (Fee £3 3s., returnable.)

XUM

Trade Talk.

Employees of the Carron Company, Falkirk, contributed during 1930 the sum of £2,031 to infirmaries and other charitable institutions.

With the launch of the tanker "Ashmore," on February 2, every berth in the three Tyneside shipyards of Messrs. Sir W. G. Armstrong, Whitworth & Company (Shipbuilders), Limited, is now empty of tonnage.

Messrs. Palmers Shipbuilding & Iron Company, Limited, Jarrow, launched on February 2 a section of a ship over 300 ft. long, which is to be built into the oil tanker "Saranac," belonging to the Anglo-American Oil Company.

The Workington Bridge & Boiler Company, Limited, have obtained an order from the United Steel Companies, Limited, for the erection of a complete automatic hoisting, charging and distributing equipment for a blast furnace at their Derwent Works, Workington.

Redler Patents, of Sharpness, announce that the engineering department of their business is now trading separately as the Redler Equipment Company. A London office has been opened at Sentinel House, Southampton Row, W.C.1, under the management of Mr. G. Gilbert Bell.

Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, have secured an order to build a turbine-propelled passenger steamer for London owners. During 1930 the output from Messrs. Scotts' yard was nine vessels of an aggregate tonnage of 51,681 and engines of 32,400 i.h.p.

An appeal to the electricity industry to put in hand all possible development work to give an immediate stimulus to employment and a revival of trade was made by Mr. Herbert Morrison, Minister of Transport, when he met representatives of Scottish municipal and private company electricity suppliers in Glasgow recently. The industry, he felt, was in a favourable position to offer a remunerative outlet for a large amount of additional capital expenditure during the next few years. It would be a disastrous economic policy if they did not get ready for the expansion in trade which would surely come. He appealed to them to make an immediate start in speeding up transmission and distribution development in advance of their normal programme. Similar conferences have been held by the Minister of Transport in other parts of the country.

Speaking at Hamilton recently, Mr. John Craig, chairman of Colvilles, Limited, and associated companies, said, in reference to the present industrial situation, that it was doubtless occurring to many people that we were paying a high price in certain trades for being pioneers in the provision of higher social services. He thought that they should not grumble, as the better conditions were being passed on. He would like to see the workers making bigger wages, as at the moment wages were poor, and it seemed to him that industrial companies were not likely to resume payment of dividends until wages were higher. Employers were often blamed for wanting low wages, but, speaking from his own experience of several industries, he could say that he had never seen good dividends when wages were low. There was no doubt that the best dividends materialised for shareholders when the wage levels were high.

Reviewing the industrial situation in his presidential address at the annual meeting of the Swansea Metal Exchange, on February 2, Mr. Frank Rees, J.P., chairman of the Llanelly Steel Company, Limited, said that, to his mind, the most vital problem was that of synchronising wholesale and retail prices. Retail prices had not kept pace with the fall in wholesale prices, and until this fall was reflected in retail prices, we would not successfully overcome the obstacles to trade recovery. With regard to the Welsh steel and tinplate industry, Mr. Rees thought that they could with confidence expect the tinplate trade to regain its lost trade as soon as there was a general world movement, but he saw very little hope of the sheet industry of this country ever regaining its old position among the chief producing countries of the world. Many of our competitors abroad were able to produce sheets at a price considerably below our own, and we found that India, for the sake of further protecting the Tata Company's output of 25,000 tons of sheets, was prepared to put an additional tax of £2 15s. 6d. per ton on imports of 200,000 tons. He could not believe that the policy of unrestricted competition from foreign countries would be allowed to go on much longer unchecked. He did not believe that safeguarding as a policy was going to solve all their difficulties. He believed that the reorganisation of the industry, with safeguarding, would accomplish much, but no reorganisation was possible until some security was forthcoming against Continental dumping.

The Bankers' Industrial Development Company, Limited, through the Bank of England, offered for subscription last month £1,000,000 of 5 per cent. first mortgage debenture stock at 95 in the National Shipbuilders Security, Limited. The stock will be redeemable by a cumulative sinking fund calculated to redeem the whole by August 1, 1961, and operating half-yearly by purchase at or under par or by drawings. The shipbuilding companies represented in National Shipbuilders Security, Limited, which has the support of practically the entire shipbuilding industry of Great Britain, Northern Ireland and the Irish Free State, have executed deeds of covenant for the payment to the company of a levy of 1 per cent. on the contract or sale price of all vessels of over 300 ft. begun after November 1 last. On the average of the last seven years this levy would have produced £293,190 per annum. The stock is to be secured under a trust deed by a first specific charge on the benefit of the deeds of covenant just described and by a floating charge on all the other assets of the company, which may not pay a dividend so long as any part of the stock is outstanding. The directors of the National Shipbuilders Security, Limited, are:—Sir James Lithgow, Bt., chairman (director of Lithgows, Limited); Sir Alexander M. Kennedy, J.P. (chairman of the Fairfield Shipbuilding & Engineering Company, Limited); and Messrs. A. L. Ayre (chairman of the Burntisland Shipbuilding Company, Limited), John Barr (vice-chairman of the Iron Trades Employers' Insurance Association, Limited), Commander C. W. Craven, R.N. (director of Vickers-Armstrongs, Limited), J. W. Kempster, (director of Harland & Wolff, Limited), John McGovern (director of the Furness Shipbuilding Company, Limited), F. C. Pyman (managing director of William Gray & Company, Limited), A. M. Stephen (director of Alexander Stephen & Sons, Limited), and R. N. Thompson (director of Joseph L. Thompson & Sons, Limited).

Obituary.

Mr. John Edwin Perry, founder of the firm of John E. Perry & Son, Limited, metal merchants, Horseley Fields, Wolverhampton, died on February 1, in his 90th year.

We sincerely regret to record the death of Mrs. J. G. Pearce, the wife of the director of the British Cast Iron Research Association and daughter of Dr Rosenhain, F.R.S., of the Metallurgical Department of the National Physical Laboratory. Mrs. Pearce was extremely well known in foundry and metallurgical circles. Leaving Cambridge with the degree of M.A., Mrs. Pearce for some time interested herself in welfare work. Her special interests were economics, education and literature, and her literary work was readily accepted by the Press and the Broadcasting Corporation. On behalf of the foundry industry, we offer to her husband and parents our sincerest sympathy.

The death of Mr. William M'Lachlan, one of the pioneers of the ironfounding industry in Denny, occurred at his home on February 1, after a long illness. Mr. M'Lachlan was in his 88th year, and was the son of Mr. William M'Lachlan, of the Carron Company. He commenced his apprenticeship as a moulder at Carron Iron Works, but migrated to Glasgow, where he served the latter part of his time. He was foreman moulder in several foundries in Glasgow and district before he went to South America to take up a position in the Pacific Steam Navigation Company's foundry at Callao. Ill-health necessitated his return to Scotland in 1878, and a year later he started the Rosebank Foundry at Dunipace, for the production of small engineering castings. Unfortunately, the country was at the time suffering from industrial depression, and after about two years Mr. M'Lachlan closed the works and became foreman with Messrs. Cruickshank & Company, of the Denny Iron Works. Sixteen years later he entered into partnership with Mr. George Paul, Carronbank Foundry, trading under the name of Paul & M'Lachlan.

Personal.

Mr. Julian Piggott, manager of the British Steel Export Association, is to pay a business visit to Canada at an early date.

On the occasion of his leaving the service of Messrs. Colvilles, Limited, Motherwell, Mr. W. A. M'Cartney was presented with a gold watch and bookcase by the directors and fellow members of the office staff.

Mr. Charles Warwick, chief timekeeper at the Dalzell Steel Works, Motherwell, has been presented with a wallet of notes and an umbrella on the occasion of his retirement after 41 years' service with Messrs. Colvilles.

Mr. G. E. Hepworth, director of Messrs. Hepworth & Grandage, Limited, engineers and ironfounders, of Bradford, has reached home after an extensive business tour of South Africa, where he visited all the principal business centres of the South African Union.

Mr. W. G. Spence, general manager of Messrs. George Clark, Limited, engineers and boiler makers, of Sunderland, is retiring from business and from residence on the North-East Coast. Present and past members of Council and founding members of the North-East Coast Institution of Engineers and Shipbuilders have made Mr. Spence a presentation as a token of appreciation of the part he took in establishing the Institution in 1884.

Mr. Richard Crocker, a patternmaker employed at the Morfa Engineering Works of Messrs. Thomas & Clement, Limited, Llanelly, has retired at the age of 76, after 52 years' service with the firm. Mr. Crocker was one of the firm's oldest employees. He relinquished the position of foreman patternmaker some years ago in favour of his son, who has been with Messrs. Thomas & Clement for 40 years. In the same shop Mr. Crocker's grandson is working as a journeyman patternmaker. A presentation of a wallet of notes to mark the occasion of his retirement was made to Mr. Crocker by Mr. J. H. Thomas, works manager.

Will.

Pearson, Walter E., a director of the New Cransley Iron & Steel Company, Limited, near Kettering £84,239

The Newcastle Electric Supply Company, Limited, have placed an order, amounting to £11,300, with Messrs. Head, Wrightson & Company, Limited, Stockton-on-Tees. The contract is for the supply and erection of the steel framework for the new switchhouse required at the Dunston "B" Power Station.

Iron and Steel Institute.—The Annual Meeting of the Iron and Steel Institute is to be held in London on May 7 and 8, under the presidency of Col. Sir W. Charles Wright, Bt., K.B.E., C.B. The Autumn Meeting will be held at Swansea during September 22 to 24. As in recent years, additional meetings will probably be held in local centres.

Strength of Grey Cast Iron at Elevated Temperatures.—The following are the conclusions arrived at by Dr. J. W. Donaldson in a Paper read before the West of Scotland Iron and Steel Institute:—(1) The strength of grey cast iron "as cast," at temperatures between 15 deg. and 600 deg C., first decreases slightly to a minimum, then rises to a maximum before falling-off rapidly. (2) The minimum and maximum temperatures and the magnitude of the resulting depression in the temperature-stress curve are influenced by the silicon content of the iron and additions of such elements as chromium, tungsten, manganese, nickel and vanadium. (3) Heat treatment for a short period (four hours) at a low temperature (300 deg. C.) eliminates the depression in the temperature-stress curve. Such treatment also slightly improves the strength values due to the releasing of casting stresses. (4) Heat treatment at 450 deg. or 550 deg. C. for 200 hours reduces the strength values and gives rise to temperature-stress curves which fall off uniformly and regularly. (5) Temperature-stress curves obtained after heat treatment are of a similar nature and value to tensile-temperature-time curves derived from "creep" tests. (6) Iron with a low silicon content or containing small additions of chromium (0.4 per cent.) or tungsten (0.5 per cent.) has a high strength value at elevated temperatures. High silicon content or a small nickel addition (0.75 per cent.) lowers the strength considerably.

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Very often a newly applied patch in a cupola is scraped off the wall by the descending charge as soon as you begin to blow. Consequently there is excess slagging and waste of coke, and the brick-work is left unprotected. Sometimes it is the

CUPOLA HAND'S FAULT,

but more often it is the result of using an inferior patching material.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—There is very little activity in the Cleveland market. The outlook is uncertain, and ironmasters have to be content with disposing of their output from day to day. Bulk purchases are almost entirely absent, and the majority of the transactions are for small parcels for delivery during the current month. The steelworks are using a little more iron than was the case a few weeks ago, and home consumers are taking slightly increased deliveries against contracts. The result is that current output is all being absorbed, and for three weeks in succession stocks of Cleveland iron have been reduced. These stocks are not really large, but the reduction will have to be sustained before any increase in the output can be contemplated. Very few export sales are reported, but Cleveland is getting a bigger share of the Scottish trade since prices were reduced, though it has only been possible to secure this expansion by quoting specially low prices.

The fixed minimum quotations for the various grades of Cleveland iron are :—No. 3 Cleveland G.M.B., 58s. 6d. per ton; No. 1 foundry iron, 61s.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s.

Hematite prices are irregular, but a rather easier tendency has developed. Consumers have been insisting for weeks past that reductions are due, and they have been simply buying from hand to mouth until some concessions were made. East Coast makers have been holding out for 70s. minimum, and some still refuse to sell below that figure. Others, however, have been more compliant, and 69s. per ton may be regarded as an average market price for East Coast mixed numbers, with No. 1 quality at 6d. premium. At these prices a fair number of small orders has been placed, but no big buying has taken place. On the North-West Coast, Bessemer mixed numbers are at 68s. per ton at works.

LANCASHIRE.—The majority of general foundries in this district are engaged at below capacity, and the same conditions apply, although probably in a greater degree, to the textile-machinery shops. Derbyshire and Staffordshire No. 3, for delivery to users in the Manchester price zone, is offered at 69s. 6d. per ton, Derbyshire forge at 64s. 6d., Northamptonshire foundry at 68s., Cleveland at around 71s., and Scottish brands of No. 3 at 90s. to 91s. West Coast hematite iron is lower at 83s. per ton.

THE MIDLANDS.—Little business of any importance has been done since the last meeting of the Midland pig-iron producers, and it is impossible to get consumers to consider that prices are at bottom. The ironfounders in most trades are short of work. Most of the buying which is now taking place is confined to small lots to cover immediate requirements. Values are unchanged at 67s. 6d. for No. 3 Northants and 71s. for Derbyshire and Staffordshire No. 3, these figures including delivery to local stations.

SCOTLAND.—Business in Scotland remains abnormally quiet. Founders generally continue to complain of lack of orders, and many of them have not bought pig-iron for months, while owing to the bad state of trade amongst the shipbuilders the outlook there is black. The export demand is exceedingly poor. No. 3 Scotch foundry iron is at 73s. 6d. f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1 quality.

Finished Iron.

The makers are finding competition keen for crown bars, and the Staffordshire figure for this grade varies between £9 15s. and £10 5s., but £9 10s. and even lower is accepted in some cases. Bolt iron is quoted at about £8 15s. There is no improvement in the demand for either grade, and working is spasmodic. Continental works continue to receive support for what business is developing from nut and bolt makers for common iron. The price of the foreign No. 3 grade is now as low as £5 delivered at inland works. The price of Staffordshire marked bars is unchanged at £12 10s. The makers hoped at the turn of the year that conditions would materially improve, but, unfortunately, orders for any tonnage are few and far between.

Steel.

All the finished-steel works are short of orders, and have difficulty in arranging rolling programmes. There is a lack of trade in both sections and plates. Restricted business has resulted in somewhat lower prices for small steel bars. The sheet trade generally is still very poor. Only a restricted business is being done in semi-finished steel. Transactions are principally of a hand-to-mouth description, and the British producers continue to receive a fair share of the business passing, as they are in most cases able to give immediate delivery of quantities ordered.

Scrap.

It is impossible to report any improvement either in prices or in the volume of the demand for iron and steel scrap on the North-East Coast. Obviously the needs of the bigger consumers are much reduced, and the steelworks can meet most of their own requirements for melting scrap. The price of ordinary quality cast-iron scrap is 48s. 6d. per ton, with machinery quality at 51s. The market in the Midlands is still in a poor position. The tone is undoubtedly firmer, but merchants state that the prices offered for new business are not attractive. Heavy machinery cast-iron scrap is offered at 60s. delivered, and ordinary heavy metal at 57s. 6d., with light cast-iron scrap at 45s. delivered. No improvement is shown in the position of the iron and steel scrap market in Scotland, and the general feeling prevailing at the moment is not very hopeful. Prices continue to be easy, as supplies greatly exceed the demand. Sellers are chary of booking ahead at the quotations ruling at present. First-quality machinery cast-iron scrap, suitable for foundries, is at 55s. to 57s. 6d., with ordinary cast iron to the same specification at 50s., cast-iron railway chairs 54s., light metal 40s., and furnace firebars at 37s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Business has been restricted on both sides of the Atlantic, and the cut of 25 points in the Exporters' quotation has done nothing to encourage buying. This reduction brought the Association price down to 10.05 cents c.i.f., equivalent to £46 8s. 9d. in sterling, which is just about 20s. above the previous low level reached last October. There has since been a further fall. On Wednesday the standard market developed a firmer tone, and there was some buying by manufacturers. However, sellers of copper are very chary about how much they sell at the ruling level.

Closing quotations :—

Cash.—Thursday, £43 3s. 9d to £43 5s.; Friday, £43 6s. 3d. to £43 7s. 6d.; Monday, £44 11s. 3d. to £44 12s. 6d.; Tuesday, £45 5s. to £45 6s. 3d.; Wednesday, £46 2s. 6d. to £46 3s. 9d.

Three Months. — Thursday, £43 1s. 3d. to £43 2s. 6d.; Friday, £43 1s. 3d. to £43 2s. 6d.; Monday, £44 2s. 6d. to £44 3s. 9d.; Tuesday, £45 to £45 1s. 3d.; Wednesday, £45 17s. 6d. to £45 18s. 9d.

Tin.—There has been a certain amount of fluctuation on the London market within rather narrow limits, the tendency being downwards. Consumers are still holding off the market, and it is reported from Germany that sales have been made at cut prices. There is nothing fresh to report of the scheme for curtailing output and shipments, but there is a good deal of scepticism as to its ultimate outcome. Recent developments have been far from favourable.

Official closing prices :—

Cash.—Thursday, £114 5s. to £114 10s.; Friday, £115 to £115 5s.; Monday, £116 15s. to £116 17s. 6d.; Tuesday, £116 5s. to £116 10s.; Wednesday, £117 10s. to £117 12s. 6d.

Three Months. — Thursday, £115 12s. 6d. to £115 15s.; Friday, £116 7s. 6d. to £116 10s.; Monday, £118 5s. to £118 7s. 6d.; Tuesday, £117 15s. to £118; Wednesday, £118 17s. 6d. to £119.

Spelter.—In spite of the fact that consumers have shown much more interest in buying than for a long time past, fresh low records have been daily established. At the moment there really seems to be nothing to check the fall, although values are well below the cost of production.

Daily fluctuations :—

Ordinary.—Thursday, £11 11s. 3d.; Friday, £11 12s. 6d.; Monday, £12; Tuesday, £12 5s.; Wednesday, £12 12s. 6d.

Lead.—Buying has been rather restricted, but, on the whole, the tone is fairly good. However, with support lacking and little immediate prospect of an increased demand from consumers, a still lower level may yet be reached before the market regains confidence.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £12 12s. 6d.; Friday, £12 15s.; Monday, £13 2s. 6d.; Tuesday, £13 10s.; Wednesday, £13 15s.

Students' Corner.

(*Continued from page* 118.)

Q.—Of what importance are risers, and their purpose generally?

Riser-boxes placed on the top-part approaching the height of the pouring basin do not ease or reduce the pressure in any form, no matter what their number or size may be. It is the top level of the molten metal either in the pouring basin or riser that must be considered and which determines the liquid pressure exerted upon the mould.

It is often a practice to place several through risers on the top of a flat surface of a casting in order to ensure that the surface be clean when machined. The utility of such risers is often questionable, as it is many times the case, regardless of the area they cover, some dirt, dust or scum will be found located between the risers, to be discovered by the planer in the machinery shop. Considering the futility of such risers, they should be applied sparingly.

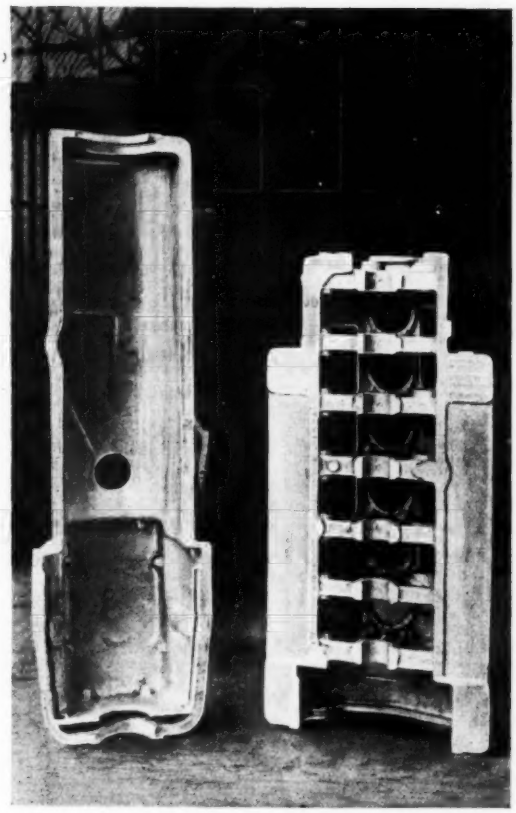
There are instances of a number of lugs, or small areas situate on the top of a casting as poured; these are often drilled and tapped or threaded. Under such circumstances the application and utility of through or "dummy" risers is effective and their use justified. In the case of "dummy" risers, a "whistler" is necessary as a "dummy" riser is a cul-de-sac. Hence a receptacle for expanded air and gases, a "whistler" provides an escape for such.

Broadly speaking, risers should be applied only for reasons referred to; through risers and "dummy" risers are chiefly used for ensuring soundness at certain parts. Whistlers are used for the escape of confined air. Cut-off risers are, in some cases, to ease the pressure, whilst in other cases indicating when the mould is filled. In exceptional cases a riser is placed on a dross trap.

The judicious, or limited, application of risers of various forms makes for economy by saving molten metal, the melting cost of which is considerable.

(*To be continued.*)

Persian Railways.—Negotiations are in progress between the Persian Government and a German consortium, consisting of Julius Berger A.-G., Philipp Holzmann A.-G. and the Siemens Bau Union Company, to extend the completed northern trial line as far as the Plain of Teheran. The length of the new extension is to be 320 km. (about 200 English miles).



Top and bottom halves of a marine engine crankcase, cast in aluminium by William Mills, Ltd., Birmingham. (Photo by courtesy of John I. Thornycroft & Co., Ltd.)

LIGHTEN THE SHIP'S CASTINGS

To the good casting properties of light aluminium alloys must be added speedy and economical machining—important advantages in producing the bulky castings of marine engineering. The founder benefits; so does the marine engineer because the first result of weight reduction is that for a definite weight of cargo the ship is not so deeply immersed, and thus running costs are lowered. But the vital point with ships whose carrying capacity is set by the Plimsoll mark is that lightness in the vessel itself means a direct increase in the cargo carrying capacity.

Write for booklet No. 317, "Aluminium in Marine Construction."

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GANISTER. LOAM AND SAND MILLS. STUDS. CHAPLETS. BRUSHES. CORE ROPES. BUCKETS. SPADES, ETC. LADLES. FIRE BRICKS. STONE FLUX. CASTING CLEANERS. PIPE NAILS. SPRIGS. WIRE BRUSHES. BELLOWS.

PLUMBAGO

CORE GUM

WHITE DUST

COAL DUST

REQUISITES

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	46	2	6
Three months	45	17	6
Electrolytic	48	12	6
Tough	45	15	0
Best selected	46	5	0
Sheets	75	0	0
India	57	0	0
Wire bars	46	10	0
Do. April	46	10	0
Do. May	46	10	0
Ingot bars	46	10	0
H.C. wire rods	48	0	0
Off. av. cash, January	44	19	7 5/16
Do., 3 mths. January	44	17	6½
Do., Sttlmnt., January	44	19	4½
Do., Electro, January	47	17	11½
Do., B.S., January	46	14	2
Do., wire bars, January	48	5	5½
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7½d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	9¼d.
Rods, extd. or rlld.	5½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	7½d.
Yellow metal rods	5½d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6½d.

TIN.

	£	s.	d.
Standard cash	117	10	0
Three months	118	17	6
English	118	15	0
Bars	120	15	0
Straits	120	15	0
Australian	119	5	0
Eastern	121	7	6
Banca	121	5	0
Off. av. cash, January	115	17	7½
Do., 3 mths., January	117	5	8½
Do., Sttlmt., January	115	17	10½

SPELTER.

	£	s.	d.
Ordinary	12	12	6
Remelted	11	5	0
Hard	9	10	0
Electro 99.9	14	10	0
English	12	12	6
India	11	0	0
Zinc dust	19	0	0
Zinc ashes	3	0	0
Off. aver., January	12	18	7 3/16
Aver., spot, January	12	14	11½

LEAD.

	£	s.	d.
Soft foreign ppt.	13	15	0
English	15	5	0
Off. average, January	13	17	9 3/16
Average spot, January	13	17	5½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	0	0
Do. V.M. ex-whf.	20	0	0
Rods	24	0	0
Boiler plates	14	15	0
Battery plates	16	15	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	24	10	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 12 6
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£15 15 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
2/4% car.	£30 2 6
4/6% car.	£23 2 6
6/8% car.	£22 7 6
8/10% car.	£21 18 6
Ferro-chrome—	
Max. 2% car.	£32 15 0
Max. 1% car.	£36 17 6
Max. 0.70% car.	£39 15 0
70% carbon-free	10d. lb.
Nickel—99% £170 0 0 to £175 0 0	
Ferro-cobalt	9/4 lb.
Aluminium 98/99%	£85 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 0 0
76/80% packed	£12 0 0
76/80% export	£12 0 0
Metallic manganese—	
94/96% carbonless	1/3½ lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	7	6
Bundled steel and shrngs.	1	15	0 to	2	0	0
Mixed iron and steel	1	17	6 to	2	0	0
Heavy cast iron				2	7	6
Good machinery for foundries				2	10	0
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	11	6
Cast-iron borings				1	5	0
Heavy forge				2	15	0
W.I. piling scrap				2	11	6
Cast-iron scrap	2	8	6 to	2	11	0
Midlands—						
Light cast-iron scrap				2	2	6
Heavy wrought				3	0	0
Steel turnings					—	
Scotland—						
Heavy steel				2	7	6
Ordinary cast iron				2	10	0
Engineers' turnings				1	12	6
Cast-iron borings				1	13	0
Wrought-iron piling				2	17	6
Heavy machinery				2	15	0

London—Merchants' buying prices delivered yard.

Copper (clean)	36 0 0
Brass	26 0 0
Lead (less usual draft)	11 0 0
Tea lead	8 0 0
Zinc	5 10 0
New aluminium cuttings	50 0 0
Brazier copper	33 0 0
Gunmetal	36 0 0
Hollow pewter	76 0 0
Shaped black pewter	56 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	69/6
Hematite M/Nos.	69/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	77/6
„ d/d Birm.	88/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	66/-
„ No. 3 fdry.*	71/-
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	62/6
„ fdry. No. 3*	67/6
Derbyshire forge*	66/-
„ fdry. No. 3*	71/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/-
„ No. 3	73/6
Hem. M/Nos.	75/-
Sheffield (d/d district)—	
Derby forge	61/-
„ fdry. No. 3	66/-
Lincs. forge	—
„ fdry. No. 3	66/-
E.C. hematite	82/6
W.C. hematite	84/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
„ fdry. No. 3	69/6
Staffs foundry No. 3	69/6
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	90/- to 91/-
Glengarnock, No. 3	—
Eglinton, No. 3	90/- to 91/-
Gartsherrie, No. 3	90/- to 91/-
Monkland, No. 3	90/- to 91/-
Shotts, No. 3	90/- to 91/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	10	0	0 to	10	10	0
Nut and bolt iron				8	15	0
Hoops	10	15	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip	10	15	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.	14	5	0			
Steel—						
Ship plates	8	15	0 to	8	17	6
Boiler plts.	9	5	0 to	10	5	0
Chequer plts.				10	12	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)	7	1	6 to	7	15	0
Flats—8 in. wide and over				8	12	6
„ under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	5	0 to	9	10	0
Black sheets, 24g.	8	10	0 to	9	10	0
Galv. cor. shts., 24g.				11	0	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	5	7	6 to	5	12	6
Billets, hard	7	2	6 & up.			
Sheet bars	5	0	0 to	5	12	6
Tin bars	5	0	0 to	5	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/-
Sheet to 10 w.g.	1/0½
Wire	1/0½
Rods	1/-
Tubes	1/7
Castings	1/-

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/0 to 10 G.	1/4½ to 1/11½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	13.00
Basic	18.76
Bessemer	19.26
Malleable	19.26
Grey forge	18.26
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.90
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.90
Plain wire	2.30
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/-
„ furnace	15/- to 17/-
Durham and Northumberland—	
„ foundry	14/- to 14/6
„ furnace	14/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box		15/6
„	28×20 „		31/-
„	20×10 „		22/9
„	18½×14 „		16/3
C.W.	20×14 „		15/-
„	28×20 „		29/6
„	20×10 „		21/-
„	18½×14 „		16/-
Terneplates	28×20		31/- per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0 to	£7	10	0
Bars, hammered, basis	£17	10	0 to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	15	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£20	0	0 to	£24	0	0
Bars and rods dead soft, steel	£11	0	0 to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ⅛ in. up to 6 in.

	Tubes.	Fittings.
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Feb.	5 ..	43	3	9	dec.	11/3
,,	6 ..	43	6	3	inc.	2/6
,,	9 ..	44	11	3	,,	25/-
,,	10 ..	45	5	0	,,	13/9
,,	11 ..	46	2	6	,,	17/6

Electrolytic Copper.

		£	s.	d.		
Feb.	5 ..	46	0	0	No change	
,,	6 ..	46	0	0	,,	,,
,,	9 ..	46	0	0	,,	,,
,,	10 ..	47	15	0	inc.	35/-
,,	11 ..	48	12	6	,,	17/6

Standard Tin (cash).

		£	s.	d.		
Feb.	5 ..	114	5	0	dec.	7/6
,,	6 ..	115	0	0	inc.	15/-
,,	9 ..	116	15	0	,,	35/-
,,	10 ..	116	5	0	dec.	10/-
,,	11 ..	117	10	0	inc.	25/-

Tin (English ingots).

		£	s.	d.		
Feb.	5 ..	115	15	0	dec.	5/-
,,	6 ..	116	5	0	inc.	10/-
,,	9 ..	118	0	0	,,	35/-
,,	10 ..	117	15	0	dec.	5/-
,,	11 ..	118	15	0	inc.	20/-

Zinc Sheets (English).

		£	s.	d.		
Feb.	5 ..	21	0	0	No	change
,,	6 ..	21	0	0	,,	,,
,,	9 ..	21	0	0	,,	,,
,,	10 ..	21	0	0	,,	,,
,,	11 ..	21	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Feb.	5 ..	11	11	3	No change	
,,	6 ..	11	12	6	inc.	1/3
,,	9 ..	12	0	0	,,	7/6
,,	10 ..	12	5	0	,,	5/-
,,	11 ..	12	12	6	,,	7/6

Lead (English).

		£	s.	d.		
Feb.	5 ..	14	0	0	dec.	5/-
,,	6 ..	14	0	0	No change	
,,	9 ..	14	5	0	inc.	5/-
,,	10 ..	15	0	0	,,	15/-
,,	11 ..	15	5	0	,,	5/-

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	13 0 0	12 5 0	11 10 0	11 16 0	11 10 0	11 10 0	11 10 0	11 10 0	12 0 0	12 0 0	12 0 0	12 0 0	11 17 1
1902	12 0 0	11 10 0	11 10 0	11 10 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 15 0	11 14 2
1903	11 5 0	11 5 0	11 5 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 7 1
1904	11 5 0	11 5 0	11 5 0	11 5 0	10 15 0	10 15 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	10 5 0	10 15 0
1905	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	11 0 0	11 5 0	11 15 0	12 0 0	10 15 0
1906	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 12 11½
1907	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 13 4
1911	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	18 3 4½
1916	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919	29 0 0	29 0 0	29 0 0	28 0 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920	46 10 0	49 15 0	53 15 0	56 0 0	55 10 0	54 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921	28 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 7 0	16 12 6	6 15 0	16 11 0½
1926	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	6 19 0	16 10 0½
1927	16 3 1	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10
1928	13 0 0½	13 2 6	13 6 0	13 3 0	13 6 9	13 11 3	13 10 0	13 10 7½	13 12 6	13 11 6	13 10 0	13 8 8½	
1929	13 11 0	13 13 1½	13 12 9½	13 10 11½	13 9 3	13 8 9	13 11 6	13 7 6	13 7 6	13 5 6	12 18 9	12 12 9½	13 7 5½
1930	12 5 0	11 15 0	11 19 6	11 18 7	11 18 0	11 17 6	11 17 6	11 17 6	11 16 3	11 12 6	11 8 9	11 5 0	11 15 11½
1931	11 4 0	—	—	—	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

SITUATIONS VACANT AND WANTED.

ELECTRIC Welder (Carbon Arc) desires change; 13 years' steel foundry experience; age 28.—Box 718, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LONDON Foundry having large output of Aluminium and Gunmetal Castings and fully-equipped machine shop, requires Representative with good selling connection.—Replies (strictly confidential) should state full details of past experience and remuneration expected to Box 722, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN wanted for small jobbing foundry casting up to 2 tons, day- and piece-work; Manchester district.—State fully experience, references and age, Box 728, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager required, used to motor trade, including centrifugal castings.—Apply, stating age, experience, and salary required, to Box 726, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, Foreman for Iron Foundry by firm of marine engineers on East Coast, experienced in modern methods applicable to medium marine and general castings up to 1,500 tons per year.—Reply, giving full experience, age and salary, Box 724, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Foreman wanted in the South-East of England; must have experience in light repetition grey iron and malleable castings.—Box 716, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

Compact and Convenient,

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

TENDER.

EASTLEIGH AND BISHOPSTOKE URBAN DISTRICT COUNCIL.

EASTLEIGH AND BISHOPSTOKE SEWERAGE AND SEWAGE DISPOSAL WORKS.

CONTRACT No. 1.

SUPPLY OF CAST-IRON PIPES AND SPECIALS.

THE above Council invite Tenders for the supply and delivery at Eastleigh of about 6,000 lin. yds. of 30-in., 27-in., 24-in., 21-in., 18-in., 15-in., 12-in., 10-in., 8-in. and 6-in. Cast-iron Pipes and Specials in accordance with the Specification prepared by the Engineers, Messrs. A. P. I. Cotterell & Son, Chartered Civil Engineers, 54, Victoria Street, Westminster, S.W.1.

Copies of the Specification, the Bills of Quantities and the Form of Tender can be obtained from the Engineers on or after Friday, February 13, 1931, by intending contractors on payment of the sum of Five Guineas, which will be returned on receipt of a bona-fide Tender and all other documents supplied.

Tenders on the form provided, enclosed in sealed envelopes, must be delivered to the undersigned and endorsed "Cast-iron Pipes—Contract No. 1," not later than 10 a.m. on Friday, February 27, 1931.

The Council do not undertake to accept the lowest or any Tender, but reserve freedom of action.

By Order,
J. LAWRENCE,
Clerk to the Council.

Town Hall, Eastleigh, Hants.

GARAGES FOR SALE.

SUSSEX (RYE).—The General Engineering Works known as The Rother Iron Works, comprising spacious Garage, Iron Foundry, Workshops, Lock-up Garages, 4 Cottages, for Sale by Auction (unless sold previously) on March 18 next.—For illustrated particulars apply, GEERING & COLYER, Rye, or JOHN BRAY & SONS, Bexhill-on-Sea.

MISCELLANEOUS.

GANISTER, best quality for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

ADDRESSOGRAPH Machine (Pedal), in good working order, with cabinet attached, including some drawers, for disposal.—Address replies to Box 1768, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOR Sale, large quantity Founders' Materials; Tools; Moulding Boxes; Core Barrels; Crucibles, etc., new and secondhand. Low prices. Further particulars on application.—KING'S, Garston, Liverpool.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BRALEY & COMPANY, LIMITED, Station Works, Ecclesfield, Sheffield.

UNIVERSAL Mixers for Sand Colours, Chemicals, Blacklead, etc., different sizes. Also Super Abrasive Grinders and Steel Attrition Grinder and Dresser. Grind to any degree of fineness.—BOOTH & SON, Grinding, Crushing and Mixing Engineers, Congleton, Cheshire.

THOS. W. WARD, LTD.

100-b.h.p. Horizontal Cold-starting Crude Oil Engine, by Ruston Hornsby.

6-in. Belt-driven "MATHER & PLATT" Turbine Pump; about 500 galls. per min. against 180-ft. head.

150-h.p. "RICARDO" 6-cylinder Petrol Engines.

105-h.p. "DAIMLER" 6-cylinder Petrol Engines.

15-ton STEAM DERRICK CRANE (Anderson), 65-ft. steel jib, 33-ft. steel mast; 80 lbs. w.p.

5-ton DITTO (Wilson), 50-ft. jib; steel built; 80 lbs. w.p.

FOUNDRY LADLES, various types and sizes.

One (about) 6-ton nearly new Clayton Tipping STEAM WAGON, boiler insured 200 lbs. working pressure.

New PRESSED STEEL SECTIONAL TANKS, plates 4 ft. 0 in. and 1 metre square; all capacities; easy to erect.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

'Phone: 287 SLOUGH

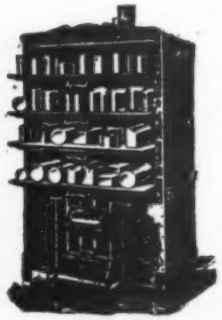
MOULDING MACHINES

1 "Coventry" headram squeezer, new	£22
2 Britannia No. 1 jolters, each	£36
1 Macdonald 24"×20" electric turnover	£40
1 Macdonald 24"×20" pneumatic turnover	£40
1 "Grimes" 36"×24" pneumatic turnover	£40
1 "Tabor" 40"×30" "Shockless" turnover	£130
1 "Tabor" 50"×42" "Shockless" plain jolt	£70
1 "Shockless" 72"×60" plain jolter	£90
4 Adaptable machines, standard type	£14

PLEASE NOTE PRICES!

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH



CORE OVEN.

THE "PORTWAY"

PORTABLE CORE OVENS

For Gas or Fuel.

TESTIMONIAL.

From The Braintree Castings Co.,
Chapel Hill Foundries, Braintree, Essex.

Gentlemen,

We are very pleased with the Core Oven we recently purchased from you. We find it dries the cores quickly without burning them. It is very handy and economical to use and is altogether superior to other ovens of this type we have in use.

Will you please quote us your best price for four more like it.

Yours faithfully,
For The Braintree Castings Co.,
(Signed) W. B. LAKE, Director.

Makers—

C. PORTWAY & SON, Tortoise Stove & Portway Portable Oven Works, **HALSTEAD, ESSEX.**